Supplement to Nature,
June 1, 1893

1125

Nature

40

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

1657

VOLUME XLVII

NOVEMBER 1892 to APRIL 1893

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH

London and New York
MACMILLAN AND CO.

RICHARD CLAY AND SONS, LIMITED
LONDON AND BUNGAY

INDEX

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

THURSDAY, NOVEMBER 3, 1892.

THE UNIVERSITY COMMISSION.

THE University Commission is sitting frequently and has heard witnesses representing nearly every interest and every shade of opinion which have a right to be represented before it. We have no knowledge of the effect which the evidence laid before them has produced upon the minds of the Commissioners; but we are sure that it must largely depend on the view which they have adopted as to the nature of their duties. They may regard themselves as entrusted with the task of finding the terms on which a heterogeneous crowd of colleges and mechanics' institutes may be huddled together, called a university, and allowed to confer degrees on such conditions as the rivalries of competing institutions may permit when tempered by the moderating influence of Crown nominees, county councillors, representatives of the School Board and of the learned societies, and any other assessors whom fancy may suggest. Such a solution might no doubt secure peace in the sense that, wearied out by long debate and hopeless of a satisfactory solution, those who are most nearly interested in the question might at last be compelled to make the best of a bad job.

This, however, must be urged against it: That almost every teacher of eminence in London, together with a large number of those best qualified to represent the educational views of the provinces, have declared *a priori* that it would be unsatisfactory.

The other view which the Commissioners may take is that they are charged with the responsible task of defining the ideal system which would best provide for the supply of the higher education in London. That having defined this ideal they are then to proceed to show by what means the closest approximation to it which present circumstances will allow can be made, and so to fashion the constitution of the University as to ensure in the future a closer approximation still. That this is the wider and more statesmanlike view is beyond question, and we sincerely hope that the Commission will adopt it. We may further hope that they will remember that although the new University should be able and willing to undertake all the multifarious duties which modern Universities have accepted as their own, the provision of the highest education and the doing all that in it lies for the advancement of learning must after all be the first and the highest duty of a University worthy of the name. As to the means which would best realize these ideals there cannot be a doubt. The present educational chaos must be reduced to order, the unwholesome rivalry between the London Colleges must be checked.

On this point Prof. Rücker, in an address recently delivered at the Yorkshire College in Leeds, made some remarks which we cannot do better than quote in full:—

"The great provincial colleges are grouping themselves into greater Universities. In the north Manchester, Liverpool, and Leeds have concluded a formal alliance. Negotiations are already in progress for the establishment of a similar confederation in Wales. The Midlands will no doubt follow suit. But if these afford, if in particular the north of England affords in the Victoria University, one of the happiest illustrations of the advantage of allowing free play to the tendencies which make for union no less than to those which encourage separation, we have, unfortunately, in London a striking instance of the harm which follows if the action of either the one or other is artificially restrained.

"The northern colleges were indeed happy in that the tendency to union was called into play while they were still in a sufficiently early and plastic stage of their history to yield easily to its influence. In London difficulties, which seemed far more serious half a century ago than they do to most of us now, have unfortunately retarded all centralizing action, till the sentiment and traditions which accumulate round institutions that have long moved independently, have enormously increased the inertia which tends to keep them in their separate paths.

"This is the more unfortunate, as if a new University of London is to be a really great teaching university, the relations between the London colleges must ultimately be closer than those which obtain between Manchester, Liverpool, and Leeds. The principle of recognizing as colleges of the University institutions for the teaching and management of which the University is not responsible, has worked and is working admirably in the north of England. It does not follow that it would succeed in London. There

is indeed a fundamental difference between the two cases. The colleges of the Victoria University are widely separated, and appeal to the strong local feeling of powerful and independent districts. A generous rivalry may therefore exist between them without ill result. Each should be left, as they have been left, to work out their own success with as little external interference as possible.

"It is sometimes argued that because the population of London largely exceeds that even of such districts as Lancashire or the West Riding, there ought to be room within it for the separate and independent institutions in which teaching of the highest type could be provided. This view ignores the importance of geographical separation, and unduly exalts that of the numerical magnitude of the population whose wants are to be met. If Manchester and Leeds were on opposite sides of the Irwell or the Aire, if they were connected by an elaborate system of overground and underground railways, then it would be more economical to concentrate, in one or the other, the higher teaching which must now perforce be given in both. The loss of time to the students in reaching the scene of their daily labours would be but imperceptibly increased, while the prestige of the colleges, great as it already is, their claims on the State, strong as they already are, would be enhanced in a proportion greater than that calculated by merely adding their separate reputations and resources. In a city of the size of London it is desirable to multiply institutions in which preparatory work of all sorts is undertaken, but I think it may be assumed as almost axiomatic that it is impossible, at present at all events, to create in one town more than one institution in which laboratories and lecture rooms and the other machinery of scientific instruction shall be provided on the large scale which the elaboration of the highest modern scientific teaching demands. In London, then, the teachers in almost all existing institutions feel the necessity for a combination of forces. They have expressed themselves as willing to be formed into battalions and regiments rather than to be left to carry on their work as isolated companies. I will not dwell on the fact that this desire could only be declared by men who were willing to risk their personal position for the public good, but I want you to observe how in this case also the work of decentralization, which began with the foundation of University College, London, has been followed and would have been far more effective had it been accompanied by a corresponding manifestation of centralizing force."

With these views we heartily agree.

If ever we are to have in London laboratories such as those which are to be found in Germany, it can only be if the higher teaching in each subject is concentrated in some one great central institution, and if rival colleges are allowed to combine their forces for the public good, instead of being compelled as at present to fritter them in suicidal competition.

Taking it for granted that all will admit that such an ideal would be the best if it could be realized, we believe that the possibility of its realization is chiefly doubted on two grounds, to neither of which any real importance is to be attached.

It has been supposed, in the first place, that those who advocate a policy of union among the London colleges think that this union must be carried out in all particulars immediately; and secondly that in order to secure this end it must be carried out by compulsion, even if the practical confiscation of the property of the existing colleges were necessary.

It need hardly be said that such a statement is a parody of the views of men who have had at least as much experience as their critics of the tone of mind of the governing bodies of great educational institutions, and who therefore would be the first to anticipate the difficulties which such demands would inevitably cause.

No responsible body has, as far as we are aware, advocated more than the establishment of a University on a basis which would permit the union of the various colleges, in whose buildings the University teaching might at first be carried on, if the colleges were themselves willing that such a union should be effected. The advocates of union have all along been striving, not to attain an immediate and complete realization of their ideal University of London, but to prevent the Charter being drawn so as to make that realization impossible. It cannot be beyond the limits of human skill to frame a scheme which shall offer every inducement to the London colleges to effect an immediate fusion, and shall further provide that any approximation which may at first take place shall easily become closer in the future.

The Victoria University does not consist of competing colleges. A federal University of London would consist of colleges which from their mere local proximity would, whether they willed it or no, be necessarily antagonistic. Unless the Commissioners fairly grasp this fact and realize that they have it in their power to lay down the lines on which a great institution shall be founded in close connection with the State, which shall concentrate under one central directing power all the educational efforts which are at present partly wasted through want of joint action, they will have failed to make the most of a great opportunity, and will have frittered the forces which, if allowed free play, are competent to do for the higher education of London all that the best friends of London can desire.

THE STUDY OF ANIMAL LIFE.

The Study of Animal Life. By J. Arthur Thomson, M.A., F.R.S.E. "University Extension Manuals." (London: Murray, 1892.)

THE chief aim of an "Extension Manual" as of "Extension lectures" is to stimulate interest and to spread information. In natural science, at any rate, it is impracticable through the medium of either Extension lectures or Extension manuals, to give that training which the student, be he specialist or generalist, can obtain only by practical work, aided by practical instruction. But there are a great number of people, some already busily engaged, others on the threshold of their life's work, who possess some interest in, and some information about, those matters, with the study of which scientific men are occupied. For them Extension lectures and manuals are a great boon; and to them Mr. Thomson's work on "The Study of Animal Life" may be cordially recommended. We trust it will stimulate them, as he would desire, to become themselves observers.

The work is divided into four parts, of which the first, entitled "The Everyday Life of Animals," deals with the wealth of life, the web of life, the struggle of life, the shifts for a living, the social life of animals, the domestic life of animals, and the industries of animals. The second part, on "The Powers of Life," contributed by Mr. Norman Wyld, treats of vitality, the divided labours of the body, and instinct. The third par describes "The Forms of Animal Life" and includes chapters on the life-history of animals, and their past history as read in the geological record. The fourth and last part treats of "The Evolution of Animal Life" and, besides a discussion of the influence of habits and surroundings, and of heredity, gives a sketch of the evolution of evolution theories. Appendices on the relation of animal life to human life, and on some of the best books on animal life bring the work to a conclusion.

The general arrangement of the subject-matter is, as will be seen by the above summary, well and carefully thought out, and the facts given in elucidation of the varied tendencies of organic development are skilfully marshalled and are derived from the most trustworthy sources. The information given is therefore accurate and up to date. The only suggestion we have to offer in this connection is that a little more selective elimination might have been exercised. Some facts are given in so terse and condensed a form that no one but a zoologist could appreciate their value. If a considerable number of these had been struck out and the space thus gained had been utilized in expanding those that remained, the Extensionee would have been the gainer. "The Zoological Summary of the Animal Kingdom" (pp. 210-272) might by some such process have been replaced by a sketch with more life and go in it. As it stands it will, by many readers, be gracefully skipped.

In such a work style is an important element. Here Mr. Thomson is often exceedingly happy. He has imagination and a feeling for the poetic aspect of nature. But his imagination and poetry need at times just a little chastening. When he tells us that in birds "the breathing powers are perfected and economized by a *set of balloons around the lungs*," and that their brains "are not *wrinkled with thought* like that of mammals"; when he speaks of the sponge as "*a Venice-like city of cells*"; when he describes the ciliated cells of the windpipe as "*lashed* cells," or the embryonic membranes as "*birth-robes*," and when he says that in ponds subject to drought the organism often "*sweats off a protective sheath which is not a shroud*, and waits until the rain refreshes the pools"; in these and sundry other cases of which these are samples, one may question whether the expressions which we have underlined are justified either by special elegancy or by real helpfulness to a beginner. And this we say in no spirit of hypercriticism, but as desirous of aiding the author in what is by no means an easy task.

Somewhat deeper would be our criticism of sundry expressions which are of essentially human implication and which in our opinion should not lightly be applied to animal activities. Much is said of the "love" of animals for their mates when some such phrase as "sexual appetence" would be more appropriate. For example, concerning ants we read:—"After this midsummer day's delight of love death awaits many, and sometimes most." And in the analysis of the forms of struggle for existence, we have the "struggle between rivals in love." Again, of the cuckoo it is said that, "in spite of the poets, the note of this 'blessed bird' must be regarded as suggestive of sin"! And again, "It is not quite correct to say that the cuckoo-mother is immoral because she shirks the duties of maternity; it is rather that she puts her young out to nurse because she is immoral." It is true that Mr. Thomson adds this footnote:—"The student will notice that I have occasionally used words which are not strictly accurate. I may therefore say definitely that I do not believe that we are warranted in crediting animals with moral, æsthetic, or, indeed, any conceptions." We are glad to be thus assured. But why implant notions in the text which have to be eradicated in a footnote? Does not Mr. Thomson know how easy it is to sow tares and how difficult to root them out?

Mr. Norman Wyld's chapter on "Instinct" is short, but quite to the point. We hope that he may further observe and experiment in the field of comparative psychology, for he is fully alive to the peculiar difficulties of the subject, and there is a wide field before him in which the scientific workers are none too many. In criticizing Mr. Lloyd Morgan's definition of instincts as "oft-recurring or essential to the continuance of the species," Mr. Wyld says:—"This is not quite satisfactory, for many actions that are instinctive are not oft-recurring, and many are not necessary to the preservation of the species." He does not show that there are any such actions which are neither the one nor the other. We have reason for supposing that he understood Mr. Lloyd Morgan to say that instinctive actions were "oft-recurring *and* essential to the continuance of the species." But this he did not say.

In conclusion we may repeat that "The Study of Animal Life," though by no means faultless, may be recommended to Extension students and the general reader as, in the main, accurate, readable, and suggestive.

C. LL. M.

VECTOR ALGEBRA.

Principles of the Algebra of Vectors. By A. Macfarlane, M.A., D.Sc., LL.D., F.R.S.Edin., Professor of Physics in the University of Texas. Reprint from the Proceedings of the American Association for the Advancement of Science, Vol. XL., 1891, pp. 65-117. (Salem Press, Salem, Mass., 1891).

THIS is a very suggestive contribution to the foundations of the Algebra of Vectors as recently so strongly advocated in America by Prof. Willard Gibbs, and in this country by Mr. Oliver Heaviside.

The extensive use of quaternions among physicists has been prevented by the fact that the meaning of a product of vectors has been made to depend on the use of a vector as a quadrantal versor, and by the fact that this method leads to the square of a vector being negative. The advocates of the new algebra define a product of vectors independently and in such way that the square of a vector is positive. Rotations are expressed by means of dyadics, or ratios between vectors

and the quaternion notion of a vector being also a quadrantal versor is not entertained at all.

The author of this pamphlet devotes a portion of it to the consideration of quaternions, which he holds should form a distinct algebra by themselves, and he suggests a special notation for them. He restricts a quaternion proper to a *pure number* (a stretching factor) combined with a certain amount of turning. A vector, on the contrary, may be a quantity of any dimensions, possessing direction, with no suggestion of turning attached to it.

He clearly shows that the objectionable *minus* which occurs in scalar products in quaternions arises from the attempt to use the same symbol both for a quadrantal versor and for a vector, so that the laws established for dealing with one set of quantities may hold also for the other set, or for a combination of the two.

It may be worth while to notice that this minus sign of the quaternionists would disappear as an explicit symbol if they considered the second vector as being drawn from the end of the first, as AB, BC, and then took the angle ABC as being the angle between the vectors—that is to say, if, in a polygon of vectors, they were to define the angles between the successive vectors to be the *internal* angles of the polygon. Indeed, by many the internal angles of a polygon (or triangle) are considered as being *the* angles between the sides, though there is loss of real naturalness and of symmetry caused by so considering them: for instance, the connection between A, B, C and a, b, c in a spherical triangle would be greatly simplified if A, B, C were to denote the *external* angles. However, if we consider these internal angles to be the angles considered by the quaternionists, the reason for the square of a vector being negative appears at once; for if a be the quantitative part (freed from the notion of direction) of a vector $\mathbf{A}$, we have $\mathbf{A}\ \mathbf{A} = a^2 \cos 180^\circ$, $\mathbf{A}$ and $\mathbf{A}$ being consecutive sides of the polygon which have straightened out till the internal angle between them is 180°.

It may therefore be contended that the quaternionists' *minus* is not quite irrational in vector algebra (though it cannot be said not to be inconvenient there), and that the advantage of being able to treat a vector as a quadrantal versor without having to establish a new set of formulæ far more than compensates for the loss of symmetry. On the other hand, the advocates of vector algebra without the *minus* would probably reply that they have to deal with vectors which are not in any sense the same as quadrantal or any other kind of versors, and that the imaginary completeness gained does not in any degree whatever compensate for the loss of naturalness and loss of symmetry involved in the *minus*.

The author differs from Prof. Gibbs and Mr. Heaviside in the mode in which he defines the product of two vectors, as he considers the *complete* product formed on the understanding that the multiplication shall obey the distributive law. He then finds that this complete product consists of a non-directed part, and of a directed or vector part, the former consisting of the product of the two quantities into the cosine of the angle between them, and the latter of the product of the two quantities into the sine of the same angle, having as axis the normal to the plane containing the two vectors. The angle is the angle through which the first vector (occurring on the left-hand side of the product) would have to turn to make its direction coincide with that of the second.

Prof. Gibbs and Mr. Heaviside, on the contrary, define the scalar product and the vector product as if they were entirely distinct and independent quantities. Finally the same result is attained, but Prof. Macfarlane's mode of introducing these partial products as arising naturally from applying the distributive law of multiplication would seem to have an advantage from the point of view of a student.

Prof. Macfarlane dwells emphatically on the importance of considering *dimensions* of vectors, as well as their direction, and to emphasize this he separates his vector, not into *tensor* and *unit-vector*, but into *quantity* and *direction*. Thus in the equation $\mathbf{X} = xi$, x is the quantity, and i denotes the axis. Hence the equation $jk = i$ is not a violation of dimensions, but is merely a convention as to the interpretation of a composite direction, a convention, moreover, which could only be adopted in space of three dimensions, and is the statement that the plane in which j and k lie has its orientation sufficiently indicated by the normal direction i, with the further convention that the angle from j to k shall be considered positive.

The author's notation is novel, and forms a very important feature in his treatment of the subject. The scalar product of $\mathbf{AB}$, which is $ab \cos (ab)$, he calls $\cos (\mathbf{AB})$ and the vector product he calls $Sin\ \mathbf{AB}$, its magnitude, irrespective of direction, being denoted by $sin\ \mathbf{AB}$. Possibly an improvement in this latter would be to denote it by $sin\ ab$, and then the capital letter in the complete vector would become unnecessary.

The particular symbol used to denote a scalar or a vector product is a matter of secondary importance, but is a matter which must sooner or later be settled if vector-algebra is to come into general use. Lord Kelvin is of opinion that a function-symbol should be written with not less than three letters, and Prof. Macfarlane's notation obeys that law, and is moreover easy to work with, but is incomplete, being applicable to products of two vectors only. Mr. Heaviside uses no prefix at all to a scalar product, but considers that $\mathbf{AB}$ means the scalar product. He uses the quaternionic expression $V\mathbf{AB}$ for the vector product. Prof. Gibbs uses no prefix for either, but denotes the scalar product by $\mathbf{A} . \mathbf{B}$, and the vector product by $\mathbf{A} \times \mathbf{B}$. The three-lettered prefix seems the clearest in both cases to denote the special product intended, and the symbols *cos* and *sin* are more or less suggestive.

In forming a product of three vectors, Prof. Macfarlane makes the convention that $\mathbf{ABC}$ shall mean $(\mathbf{AB})\mathbf{C}$, the combination commencing on the left. In his notation this product expands into

$$
\begin{aligned}
&(\cos \mathbf{AB} + \mathrm{Sin}\ \mathbf{AB})\mathbf{C} \\
&= \cos(\cos \mathbf{AB} . \mathbf{C} + \mathrm{Sin}\ \mathbf{AB} . \mathbf{C}) + \mathrm{Sin}(\cos \mathbf{AB} . \mathbf{C} + \mathrm{Sin}\ \mathbf{AB} . \mathbf{C}) \\
&= \cos(\mathrm{Sin}\ \mathbf{AB} . \mathbf{C}) + \mathrm{Sin}(\cos \mathbf{AB} . \mathbf{C}) + \mathrm{Sin}(\mathrm{Sin}\ \mathbf{AB} . \mathbf{C}) \\
&= \mathrm{vol}\ \mathbf{ABC} + \mathbf{C} . \cos \mathbf{AB} + \mathrm{Sin}(\mathrm{Sin}\ \mathbf{AB} . \mathbf{C})
\end{aligned}
$$

which finally becomes

$$= \mathrm{vol}\ \mathbf{ABC} + \mathbf{C} \cos \mathbf{AB} + \mathbf{B} \cos \mathbf{AC} - \mathbf{A} \cos \mathbf{BC};$$

where vol (**ABC**) denotes the volume of the parallelopiped of which **ABC** are three adjacent edges. The only objection to this name lies in its suggesting that **A**, **B**, **C** are *linear* vectors.

Here appears the defect in the author's *cos* and *sin* notation, in that it cannot be applied to the products of three vectors, or at least that the special reason for its use has disappeared, and the author does not suggest so applying it.

But there is a certain perspicuity attained by this very limitation of the *cos* and *sin* notation to the products of only two vectors, inasmuch as there can be no ambiguity in the meaning of an expression in which they occur, even if brackets are omitted or placed differently. Indeed, instead of cos (Sin **AB** . **C**) the author writes cos (Sin **AB**)**C**, which seems a curious use of the bracket. But cos Sin **AB** . **C**, or preferably cos **C** Sin **AB**, is just as explicit, and even cos Sin **ABC**, though wrong to write as being puzzling, can only have the same meaning.

The author concludes with short sections on dyads and matrices, on scalar- and vector-differentiation, including scalar-differentiation of a quaternion. On the last page are a series of propositions relating to the addition of scalar and vector quantities situate at, or passing through, specified points.

The pamphlet is confined solely to statements of principles and the section devoted to dyads and matrices is very condensed, so that it is not in any sense a text-book for students. It is rather a synopsis of the subject, with the introduction of a special notation which the author has found useful. A text-book of vector algebra, with examples showing its application to problems in geometry, mechanics, and general physics, and contrasting the method with the Cartesian method of treating the same problems, is much needed, as many physicists are becoming interested in the new algebra, owing in great measure to Mr. O. Heaviside's able exposition of its principles and applications in the *Electrician* and elsewhere.

THE LAKE OF GENEVA.

Le Léman: Monographie Limnologique. F. A. Forel. Tome Premier. (Lausanne: F. Rouge, 189-.)

PROF. FOREL has been for some years occupied in studying the Lake of Geneva, and has now published the first instalment of the fruits of his labours. The work, when finished, is intended to be a complete monograph of the history of a single lake, and will be a most important contribution to an interesting branch of physical geography. In the present volume the geography, the hydrography, the geology, the climatology, and the hydrology of Lake Léman are discussed, after some introductory matter relating to the instruments employed in sounding with other preliminaries. But, though only a single volume, the work embraces so many questions that we must, for want of space, confine our notice mainly to one, which, of late years, has attracted the most attention, at any rate in this country, viz. What has been the origin of the lake basin? Was it formed by the old Rhone glacier or in some other way? The especial value of Prof. Forel's memoir is the number of new facts which it brings to bear on the problem thus propounded.

The Lake of Geneva, however it may have been caused, is more modern than the middle of the Miocene period: "Le lac n'existait pas encore, la vallée du Léman n'était pas même indiquée quand la mer helvétienne déposait les mollasses d'Epalinges et du Mont." Its slopes, and almost certainly its bed, are covered with glacial deposits, of later date than the formation of its basin. Terraces around its shore indicate that its waters once reached a higher level, the greatest elevation which can be identified with certainty, being about 30m. above the present surface. The next pause was at 10m.; after that the lake sank (the fall always being rapid) to its present level. Traces of still higher terraces are to be found on the north shore, but as these neither can be identified on the opposite side, nor correspond with any natural barrier in the course of the Rhone below the lake. Prof. Forel doubts whether they indicate old levels of its waters.

Lake Léman consists of two basins. The first and larger extends from the embouchure of the Rhone to the narrow of Promenthoux. At the east end the slope of the cone of alluvium deposited by the Rhone in no part exceeds 25°. First comes a zone of very shallow water off the actual shore line; to this succeeds a more rapid slope, which gradually eases off as it descends. The current of the Rhone has made and maintains a well-marked channel in this mass of detritus, and the contour lines are affected down to 250m. At the embouchure of the Dranse, on the south shore, another alluvial cone has been deposited. This, however, is rather steeper, but it is much smaller, and does not perceptibly affect the course of the subaqueous contour lines below about 200m. On the north side of the basin the slope varies. Under the walls of Chillon the descent is rapid, amounting to 137 in 100; it is nearly the same near St. Gingolph on the opposite shore, doubtless indicating submerged crags; but it is generally more moderate. West of Vevay it is about one in four, whence it changes gradually to one in ten opposite to Ouchy.

West of this port the descent is still more gentle, and so it continues round the western end of the basin, the lip of the latter being 75m. below the surface. The contours of the south side correspond generally with those of the north, and the form of the basin is evidently related to the geology of the district, being narrower and steeper among the harder rocks at the eastern end. The deepest part is a large rudely triangular area, the apex pointing towards the west, and the base lying roughly north and south, extending from almost opposite to the embouchure of the Dranse to near Lutry. All this area is an almost level plain, for it is wholly below the 300m. contour line, but the greatest depth obtained was only 309·7m.

The Petit Lac may be described as a comparatively narrow and shallow trough, rising very slowly from a depth of about 70 to 50 metres, and then gradually mounting to the embouchure of the Rhone, its bed being slightly interrupted by five small shallow basins, which roughly speaking, have a linear arrangement, but their floors only sink four or six yards at most below the general level.

The lake to some extent is still held up by the huge mass of gravel brought down by the Arve, through which the two rivers have now cut their channels on either side of the plateau of La Bâtie below Geneva. But it is

in the main a true rock basin, though its bed no doubt is concealed beneath glacial deposits and the finer mud brought down by rivers. This alluvium has been studied by Prof. Forel, but into the matter we are unable to enter.

Both the origin of lake basins in general and of that of Léman in particular are carefully discussed by Prof. Forel. He examines, only to reject as attended by insuperable difficulties, the hypothesis that it was excavated by the old glacier of the Rhone. He shows that the subaqueous portion corresponds in its general features with a river valley, and is only a prolongation of that of the Rhone. This valley was first defined at a very early period in the uprising of the Alps; its excavation progressed with their growth; it was practically completed at a time when they were higher, perhaps by some 1000 m., than at present. Then the lake was formed by a general subsidence of the mountain region, the lowland remaining comparatively unaffected. The movements of the parts depressed may have been to some extent differential; but this, in Prof. Forel's opinion, is not a necessary assumption. To us, however, it appears that it would be very difficult to explain the rock barrier at St. Maurice between the upper and lower plains without some amount of differential movement. Prof. Forel's view, of course, is not novel; for it has been long maintained in England as a general explanation of the greater Alpine lakes by a few geologists, who never bowed the knee to the glacial Baal With their writings, however, Prof. Forel does not appear to be acquainted, though they appeared in publications generally accessible.

The remainder of the present volume is occupied by a discussion of the temperature, rainfall, and general hydrology of the Lake Léman region. It is full of interesting facts and discussions, which we would gladly notice did space permit. The book is well printed, and contains many illustrations, together with a large map of the lake on which the subaqueous contours are depicted. If the book were less diffuse its scientific value would have been greater, but Prof. Forel pleads in excuse that he aimed at writing a volume which would be also acceptable to the general public, or in other words, would combine meat for men with milk for babes. As a comprehensive history of a lake is a great desideratum, it would be ungracious to find fault with Prof. Forel's very natural desire to secure a large number of readers and of purchasers. T. G. Bonney.

OUR BOOK SHELF.

Horn Measurements and Weights of the Great Game of the World, being a Record for the use of Sportsmen and Naturalists. By Rowland Ward, F.Z.S. (London: Published by the Author, 1892.)

In these days, when every one is striving to "beat the record," it is only right that sportsmen should have clearly put before them the results already arrived at as regards the size of the trophies and the weight of game-animals already obtained by their brother Nimrods. No one is in so good a position to do this as Mr. Rowland Ward, to whose well-known "jungle" in Piccadilly all the leading shooters of the present day send their "heads" to be mounted and their "skins" to be stuffed. It is, however, much to be regretted that Mr. Ward did not take into his councils some brother "F.Z.S." more versed in scientific knowledge than himself when he prepared this volume, or at any rate did not have the proof-sheets revised by some zoologist with a good knowledge of the Mammalia. The consequence of this want of foresight is that the nomenclature and localities upon which the importance of the records entirely depends are in a very confused state, and in many cases quite erroneous.

Take the Deer (Cervidæ), for instance. Of this family a very correct and accessible list, drawn up by the late Sir Victor Brooke, has been published in the "Proceedings" of the Zoological Society for 1878, which Mr. Ward would have done well to follow. But we find under the Sambur (*Cervus aristotelis*) a head from "Java," where this species certainly does not occur, recorded in the list. Next to this (p. 10) comes the "Central and South Indian Sambur, *Rusa hippelaphus*" (whatever this may be), but three out of the four specimens assigned to it are from Nepal! On the other hand, several heads from Java are attributed (p. 22) to *Cervus rusa*, which is merely a synonym of *Cervus hippelaphus*.

The heads of the large Deer of the Caucasus obtained by Mr. St. George Littledale are assigned (p. 28) to the Red Deer (*Cervus elaphus*). But we have good reason to know that they really belong to the Persian Deer (*C. maral*), quite a different species.

Looking over the list of Antelopes, we find similar errors prevalent, though perhaps not quite to so great an extent. The specimens of the Chiru (*Panthalops hodgsoni*) are assigned to "India," whereas this Antelope is only met with in the snow-fields of Ladakh and Tibet. Nor can the "Takin" (*Budorcas taxicolor*) be properly stated to be from "India." It occurs only in the Mishmi Hills on the frontiers of Assam.

These and many like mistakes are the more serious as Mr. Ward's volume is well got up, nicely illustrated, and likely to be frequently used by the sporting naturalist. But the statements contained in it cannot be relied upon for scientific accuracy.

Der Peloponnes. Versuch einer Landeskunde auf geologischer Grundlage. Von Dr. Alfred Philippson. (Berlin: R. Friedländer and Son, 1891-1892.)

Greece has hitherto been interesting mainly to scholars, archæologists, and lovers of art; and no doubt it is from their various points of view that the country will always be most eagerly studied. The subject, however, has also elements of attraction for students of natural science, and it is to these elements, so far as the Peloponnese is concerned, that Dr. Philippson has sought to do justice in the present work. His results have been obtained by direct personal observation, and are set forth with admirable clearness. The book is divided into two parts, the first of which is called "special," the second "general." In the "special" part the author deals with particular regions of the Peloponnese; in the "general" part he presents an account of the peninsula as a whole. Dr. Philippson is a careful and accomplished geologist, and has been remarkably successful not only in throwing fresh light on the geological phenomena of the country, but in showing their relation to the various orders of facts which come more especially within the province of the geographer. He has also excellent chapters on the forms and phenomena of the surface, on climate, on vegetation, on the animal world, and on the population. In dealing with the last of these subjects he has much that is valuable to say about productive industry, means of communication, density of population, and towns, villages, and other settlements. The interest of the work is greatly increased by maps and profile-sketches.

Traité Encyclopédique de Photographie. By Charles Fabre. (Paris: Gautier-Villars and Sons, 1892.)

In a previous number of Nature (vol. xlvi. p. 464) we noticed the first part of the supplement which M. Fabre

proposes to bring out triennially. The present two volumes form a continuation, and extend as far as § 5 of the second chapter in the second book. The author proceeds on the same lines as formerly, and places before the reader in a concise way all the new methods of development, measuring lenses, apparatus, &c., from the particulars of constitution which characterize developers down to the latest form of kodak or tie camera. Not only is each subject treated with the greatest care, but illustrations are numerously distributed. That which will add great value to the work as a whole is the insertion of references, for what, after all, is more annoying than having to wade through a great quantity of literature when the presence of one or two words would have eliminated all trouble? W.

The Reliquary: Quarterly Archæological Journal and Review. Vol. VI. (New Series). (London: Bemrose and Sons, 1892.)

THIS volume consists of the four numbers of *The Reliquary* which have appeared during the present year. The contents include many things which do not quite come within the scope of NATURE; but it is satisfactory to be able to note that the writers, speaking generally, have done their work in a thoroughly scientific spirit. Mr. J. Lewis André contributes an interesting and well-illustrated paper on leather in the useful and ornamental arts, and a clear account is given by the editor of a part of an early dial, bearing runes, which he was lucky enough to find some months ago in the churchyard of Skelton, Cleveland. An illustration gives a good impression of the general character of the stone, the runes on which, according to Canon Browne, are "Danish." Among the other papers are two articles, by Mr. D. A. Walter, on ancient woodwork, and a discussion, by the Rev. A. Donovan, of some of the problems connected with the career of Columbus.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Nova Aurigæ.

ON October 5 the Nova Aurigæ was again observed under favourable circumstances, and the observation as to precautions in focussing necessary on account of chromatic aberration of the refractor was amply verified. [NATURE, September 22, p. 489, in which note two corrections should be made: eighth line, for "varying" read "ranging," and fourteenth line, for "(? F)" read "(? G)"] The line near C was distinctly seen at times; but the blue and violet lines observed on September 14 were not seen; the three green lines were very distinct.

On October 14 the red line was much fainter, but there was an obvious bright line in the yellow, which may be the line which Dr. Copeland estimated as 580·1 on August 28 (NATURE, September 15), or may be that which has been measured several times at the Lick Observatory (*Astrophysics*, October, p. 717), and appears to have a wave length of about 575. It had escaped my notice before, but I was induced to look most carefully in the yellow by considerations arising out of an attempt to reconcile Mr. Barnard's observations of apparent nebulosity surrounding the Nova, as seen in the 36-inch refractor at Mount Hamilton, with my own observations of September 14. Mr. Barnard's "stellar *nucleus*" was the difficulty. There appears to be no doubt that the Nova is emitting a spectrum similar to that of a planetary nebula, but it seems to me necessary to have further spectroscopic evidence before it is established that nebulous extension can be seen; if it is to be seen with a simple eyepiece, it must be looked for in a reflecting telescope, as the following considerations will show.

Prof. Keeler's study of the chromatic correction of the Lick Refractor shows ("Pub. Ast. Soc. Pacific," Vol. II. p. 164) that the circle of aberration of F light on the focal plane for the D line has a diameter which is in terms of the focal length ·0000349. We may take this diameter as very nearly that of the circle of aberration of D light on the focal plane for the F line. Thus if a star emits only D and F light, and the F light is focussed, then the D light will fill a circle nearly 7″ in diameter, and the star will look like a planetary nebula with a stellar nucleus. If the star emits light of wave lengths 500 and 575, then interpolation based on Keeler's measurements shows that round a stellar nucleus in the focus for wave length 500 there must be a circle of aberration of nearly 4″ diameter.

Mr. Campbell found lines of wave lengths 500 and 575 in the spectrum of Nova Aurigæ with respective intensities 10 and 1. Mr. Barnard describes the appearance of nebulosity as "pretty bright and dense," and as measuring 3″ diameter. My own inability to see either the circle of aberration for the yellow line when the green was focussed, or the alleged nebulosity, may be explained in several ways (*e.g.* smaller aperture of object glass, climatic conditions, &c.). The spectroscope could probably decide the question at Mount Hamilton by showing whether the *minimum* length of any of the lines is that corresponding with 3″ diameter on the slit. I have not been able to do more than observe that the yellow line is not visible when the 500 line is focussed on the slit of a spectroscope having an effective dispersion of two 60° prisms. H. F. NEWALL.

Observatory, Cambridge, October 24.

Formation of Lunar Volcanoes.

WHILE we have, on the lunar surface, a series of markings so evidently volcanic that no one thinks of applying any other term to them, we have on the other hand no explanation of their mode of formation which will stand examination. The explanation given by Messrs. Nasmyth and Carpenter in their splendid work on the moon, founded upon explosive expulsion of lava, fails to satisfy the mind when applied to wide craters with a low wall such as Shickard or Grimaldi, of which there are so many on the moon, and which look more like some disturbance in a semi-liquid surface than an accumulation of volcanic débris.

The umbrella-like eruption figured in Messrs. Nasmyth and Carpenter's book does not represent any phenomenon within our experience, as the erupted material (unless light enough to be driven by wind) invariably falls back into the neighbourhood of

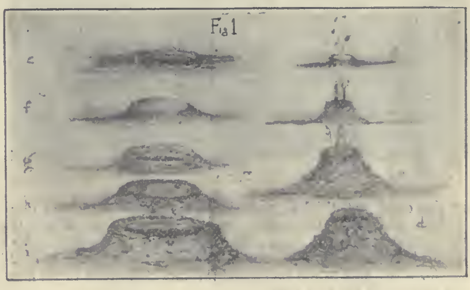


Fig 1

the vent, and we could not conceive of its being shot neatly out twenty-five miles on every side to form the familiar ring.

An explanation of the mode of formation founded upon lunar tidal motion occurred to me about seventeen years ago, from observations on a cooling slag; but until the recent publication of Mr. Darwin's work on the history of the tides I was doubtful if that force were sufficient to account for observed results.

I had noticed that the rise and fall of a fused slag through holes in its solidifying crust, formed craters exactly like those in the moon; and I enclose a photograph of a piece of that slag in which is reproduced all the salient features of the lunar surface.

The mode of formation was as follows:—

The fused liquid (which was potash "black ash" containing a mixture of substances of very varied melting point) was still giving off some gas, which escaped as at *a* in Fig. 1, building up

a miniature crater as at *b*, *c*, *d*. But the crater vent becoming intermittently choked, the accumulation of gas beneath the crust caused the liquid "lava" to rise through any neighbouring holes as at *e*, *f*, giving rise to a ring crater. The pressure of the accumulated gas now drove out the obstruction in *a*, when the liquid lava receded in *e* as at *g*. This intermittent action went on till the crater *i* was built up—entirely by "rise and fall" (as of a tide), no gas escaping at this hole.

In the case of the moon the rise and fall would be caused by the tidal motion of the still liquid interior. The solid crust would resist the periodic rise of the liquid interior, and the liquid would well through the crust and recede again as the wave passed.

When the crust was thin, and the lava very liquid, the large ring structures would be formed, as the lava would flow far; but

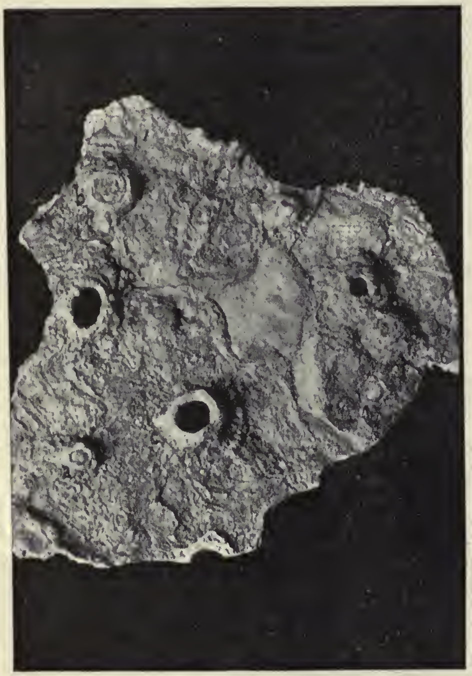


FIG. 2.

as the crust got thicker and the lava more viscid, the more striking craters like Copernicus would be built up. When the vent was very small, or the lava very viscid, the exuded lava would build up mountain ranges, or peaks like Pico, as it could not flow far, and would be cooled too much to allow of its flowing back with the ebb tide.

The existence of the cause proposed by Messrs. Nasmyth and Carpenter, viz., expansion on solidification, is very doubtful. The proof they adduced was that a piece of solid slag would float on liquid slag. But when slag solidifies it becomes filled with small cracks, which doubtless contain air, and so aid in the flotation. When I was working at this subject I had some slag poured into an iron mould kept cool by immersion in water. When the slag had cooled a distinct depression was seen on the upper free surface, showing that the slag had contracted during solidification. No doubt its contraction or expansion will depend upon its composition, and we do not know the composition of the moon's surface, but we need not depend upon a doubtful property for an explanation when a set of conditions have existed which must have yielded an ample force for the production of the observed results.

In the photograph marked Fig. 2, at *a* can be seen a crater with a raised floor and a central cone, at *b* a crater filled to the lip like "Wargentin," while on the plain near *b*, and round the open crater *c*, will be seen numerous minute craters, as on the moon's surface in the neighbourhood of "Aristotle" or "Copernicus," while in other photographs are seen walled plains like the "Mare Crisium," so that all the important features of lunar topography are reproduced in this slag, and there are many minor points of agreement which cannot be gone into in the limits of a letter.

Although I have always considered the tides the cause of the wonderful lunar configuration, I was not satisfied that that cause alone was of sufficient magnitude, till the work of Mr. Darwin placed the matter in such a clear light that I now venture to submit the idea to your readers as a feasible explanation of the familiar lunar features.

J. B. HANNAY.

On the Need of a New Geometrical Term—"Conjugate Angles."

IN geometrical discussions, such as arise out of a great variety of physical problems, it is frequently necessary to refer to an acute or obtuse angle A as being equal to another acute or obtuse angle B, because contained by two straight lines which are respectively perpendicular to those containing the angle B. Such a statement of the reason of the equality is, however, cumbrous. Sometimes, indeed, such angles when acute might be described as equal because they are the complements of equal (because vertically opposite) angles; but it will often happen that the figure does not show the vertically opposite angles that would be referred to.

I should be glad to know whether there is any term expressing the relation in question in use among either English or foreign writers, and, in default of such, would suggest that such angles be called *conjugate*, or if greater precision is required, *rectangularly conjugate*, the general term *conjugate* to be used when we wish to refer to an angle A as equal to an angle B because contained by sides whose directions are the directions of the sides of B, after each has experienced an equal and similar rotation in the plane of the diagram, whether the rotation is through a right angle or not.

The shorter inclusive term *conjugate* could always be used for the less general but longer term *rectangularly conjugate*, when brevity was aimed at.

A. M. WORTHINGTON.

R.N.E. College, Devonport, October 30.

Printing Mathematics.

THE main features of mathematical work that give trouble in printing are three: the expressing of (1) fractions, (2) powers, (3) roots.

(1) To simplify the expression of fractions we have the solidus suggested by Sir G. Stokes. But the solidus has been hitherto much less used than it might be, on account of the uncertainty as to how far its influence reaches in any expression more complicated than the simplest fractions. This uncertainty can easily be removed, and the usefulness of the solidus greatly extended by defining more definitely its exact meaning. This is done in the simple conventions proposed below.

(2) To express the process of involution, the sign $\diagdown$, suggested by Mr. C. T. Mitchell in the *Electrician*, is more concise and clearer than that mentioned by Prof. S. P. Thompson in NATURE. And Mr. Mitchell's sign, if defined by conventions similar to those applied below to the solidus, is capable of a like extensive application.

(3) To express roots we have the sign $\surd$. But, when accompanied by a horizontal line above to show the extent of its influence, this sign also requires special spacing. But it can be brought into line with the rest by the use of the same conventions.

Taking then for

α. the sign of division ... ... $/$
β. ,, ,, involution ... ... $\diagdown$
γ. ,, ,, evolution ... ... $\surd$

we may use each of these signs in either of two ways:—

I. Simply as a sign of operation, in which case it can influence only the quantities immediately adjacent to it.

II. In a double capacity—

(1) As a sign of operation.

(2) As one end of a bracket, of which the other end is $|$. This bracketing influence may be directed either forwards or backwards, or both ways at once.

Examples.

α. Division.

$$\frac{a+b}{c} + d = \;|\, a + b/c + d,$$

$$a + \frac{b}{c+d} = a + b/c + d\,|,$$

$$\frac{a+b}{c+d} = \;|\, a + b/c + d\,|,$$

$$a\,.\,\frac{b}{c}\,.\,d = ab/cd, \quad a\,.\,\frac{b}{cd} = ab/cd\,|,$$

$$\frac{a}{b+c}(d+e) = a/(b+c)(d+e),$$

$$\frac{a}{(b+c)(d+e)} = a/(b+c)(d+e)\,|,$$

$$\sin\frac{\theta}{n} = \sin\theta/n, \frac{\sin\theta}{n} = \;|\sin\theta/n.$$

Continued fractions also can readily be brought into one line by this notation—

$$\frac{a}{b+}\,\frac{c}{d+e+}\,\frac{f}{g} = \;|\, a/b + c/(d+e) + f/g\,|,$$

β. Involution.

$$a^b = a\backslash b,\; a^{-b} = a\backslash -b,$$

$$(a+b)^c + d = \;|\, a + b\backslash c + d,$$

$$a + b^{c+d} = a + b\backslash c + d\,|,$$

$$(a+b)^{c+d} = \;|\, a + b\backslash c + d\,|,$$

$$(a+b)^{\frac{c+d}{e+f}} = \;|\, a + b\backslash\,|\, c + d/e + f\,|.$$

$a\backslash b/c$ and $a/b\backslash c$ are ambiguous, but $|\, a\backslash b/c = \frac{a^b}{c}$, because $|$ being unnecessary for $\backslash$ in this case, can apply only to $/$. $\frac{(a+b)^c}{d}$ is $\|\, a + b\backslash c/d$, two vertical lines being required.

Similarly $|\; a/b\backslash c = \left(\frac{a}{b}\right)^c,\; a/b\backslash c\,| = \frac{a}{b^c},\; a\backslash b/c\,| = a^{\frac{b}{c}},$

$$a\backslash b\backslash c\backslash d = a^{b^{c^d}}.$$

γ. Evolution—

$$\sqrt[n]{a+b+c} = \;|\, n\sqrt{}\, a + b + c\,|,$$

$$\sqrt[a+b]{c+d} = \;|\, a + b\sqrt{}\, c + d\,|,$$

$${}^{a+b}\!\surd\, c + d = \;|\, a + b\sqrt{}\, c + d,$$

$$a + b\,.\,\sqrt{c+d} = a + b\sqrt{}\, c + d\,|,$$

$$a + \sqrt[b]{}\, c + d = a + \,|\, b\sqrt{}\, c + d.$$

In some cases lines of differing thickness might be advisable; for instance—

$$\frac{b^{\frac{1}{2}}}{c(d+e)^3} = \mathbf{|}\, b\backslash 1/2\,|\; \mathbf{/}\, c\,|\, d + e\backslash 3\,\mathbf{|}.$$

There are many other ways in which this notation might be used; but the above will suffice to illustrate the advantages of it. And these advantages are substantial. It enables the work to be printed in the same space as ordinary letterpress, and thus avoids the special spacing, from which nine-tenths of the troubles in mathematical printing arise. It requires no new types, except, perhaps, $\backslash$, and each of the signs used is suggestive of the original mode of writing for which it is a substitute. It can be used without confusion in conjunction with all ordinary brackets. How far this notation would suit very complicated expressions, is a point that would have to be determined by experience; but for printing mathematics of ordinary complexity it would be useful in economizing space and diminishing the risk of printers' errors without any sacrifice of clearness.

Cambridge, October 27. W. CASSIE.

"Sunshine."

IN acknowledging the courteous criticism and the kind remarks which "C. V. B." has been pleased to make about my little book, may I be permitted to comment on one or two points, which I think he has imperfectly understood from the text. We all know that when "C. V. B." undertakes to review a book, he does his work in a thorough and searching manner, and from his critique it is evident that "Sunshine" has been well read. Notwithstanding this, in one or two of the instances selected for criticism the meaning, at once simple and obvious to a little child, who neither knows nor suspects any other, seems to have missed him, presumably because he knows all the bearings of the subject. Thus it is sometimes a disadvantage to be learned. Of this I propose presently to give an instance in the order which it occurs.

After poking fun at me, because, the "Sunshine" course being ended, Tommy meets King Sol face to face and "has it out with him," my critic proceeds to discuss the limits within which the imagination may be appealed to as a factor in scientific education, and while I agree with him in the main, I am tempted in passing to remind him of what Tyndall terms "the scientific use of the imagination," to which the clearness and (to me) the charm of his own lectures is largely due. Be that as it may, in one of "Nature's Story Books" I feel fully justified in employing, *within the limits of scientific accuracy*, any or all of the powers of the mind, which shall help children and others to *realize* the relation they bear to their surroundings, assured that in a course based upon some hundreds of experiments synthetically worked out and deductions made—a course whose main object is to lead children to go direct to Nature, *via* experiment, for their knowledge, there is little danger that the imagination be cultivated at the expense of the reasoning faculties. The experience of the writer is that the children attending the lectures became extremely critical—a state of mind which, although of inestimable value in acquiring knowledge, is not one of the happiest in other respects. Therefore it was thought desirable to provide them with some necessary ballast, and this is my defence of the hypnotic visit to the moon, and the other two chapters to which the critic alludes.

Natural science apart, it seems to me that the tendency of the school-teaching of to-day is calculated rather to make children hard and matter of fact. For this reason I have endeavoured in these Sunshine Stories to interest children in the poetry of their common lives, myself playing somewhat the *rôle* of an optical instrument, presenting images sometimes real, sometimes virtual of those physical beauties which touch them at every point. The fact that "C. V. B." recognizes in "Sunshine" the *realism* which the "picturesque language" was intended to convey, disposes of the case of my Cape Town reviewer, who mildly insinuates that I have been guilty of some *fraud* upon little children in calling "Sunshine" a story-book. Therefore I am the more glad that "C. V. B." agrees with me that the mathematical side of these questions should not be obtruded. There are so many excellent text-books which supply that information for older pupils. I need not say that I shall be most happy to add the exception in the case of the rainbow. I thank him also for pointing out a passage in the notes where an additional clause is necessary, owing to the transposition of a paragraph. But I take exception to the statement about the top, for it is evident that the experiment is not made under the same conditions as that which "C. V. B." has in mind, because my boys get green and he gets (he says) white, or nearly white. The home experiment reads: "I am giving each of you squares of coloured paper to take home . . . then you may have the papers to put on your tops—*e.g.*, cover half blue and half yellow, spin the top and you will see green." A note on page 341 refers to the kind of paper. Now it seems to me from the expression "painted disc," which "C. V. B." has made use of, that possibly he may have had Clerk Maxwell's top in mind when he wrote.

When I say to a boy, "Here are two squares of paper, one blue and one yellow; when you've done so and so, you can have the paper to keep—cover your top, half yellow, half blue, &c.," the lad understands me, and when I am not there he takes out his halfpenny whip-top, tears a piece of the blue paper, and rendering it slightly adhesive hammers it down on the top with his right fist; he tears a similar piece and treats it in the same way, and so on until he has covered half. Then he takes the yellow paper and covers the other half with irregular patches of yellow. He spins the top and sees green.

How different is this from Clerk Maxwell's top. Clerk Maxwell selected for his top the purest of paper and pigments. He endeavoured to match the spectral colours (considerably diluted). He selected a scarlet red with a tinge of orange like *orange-red vermilion*, lying in the spectrum one-third the way towards D, between the lines C and D. His green was one-fourth the distance from E, between E and F, and resembled emerald green. He also selected a blue violet midway between F and G, which was imitated by that purest of colours—ultramarine. Now let us try the given experiment under the favourable conditions guaranteed by Maxwell's discs, viz., the purest of colours painted on Whatman's paper. Taking up a disc of ultramarine and another of pale (not orange) chrome yellow, and concealing half of one disc behind the other, on rotating the compound disc so that the eye shall receive simultaneously blue and yellow light, the result is not white or even practically white, but a *grey, tinged with yellow*. By a careful adjustment, hiding more of the yellow and exposing more of the blue (thereby *altering* the proportions of the text), it is possible to get rid of this yellowness and to obtain an absolutely neutral grey which it might be possible to persuade some grown-up people represented white, but which on analysis yields 71½ per cent. black to 28½ per cent. white. This may be proved by revolving a disc of black and white sectors in the above proportions, the results in each case being identical. But even this result, unsatisfactory as it is, does not apply to the passage quoted in the text, in which no special conditions are observed. I maintain what is easily proved by experiment in less time than it takes to write it, that when ordinary colours, *e.g.*, gamboge and Prussian blue, are used, the residual light is green.[1]

I fear that already this letter is too long, and since I do not wish to monopolize the space kindly placed at the disposal of your correspondents, I must defer the consideration of the annotations on soap films. The other points are dealt with in the preface. AMY JOHNSON.

52 Lower Sloane Street, S.W., October 12

I DO not think that the observations on my review of "Sunshine" require more than a very short answer.

I considered that the authoress had not by any means cleared the confusion which usually exists as to the meaning of the expression "mixing of colours." It is applied both to the case where two or more colours are seen superposed, *e.g.* by spinning coloured paper where the resultant tint is due to the sum of the separate colours in the constituents, and to the case of mixed pigments where the resultant tint is that which is common to the constituents. Now as the common "paint box" rule says that blue and yellow make green, that is that blue and yellow pigments mixed produce a green pigment, it seems to me very misleading to say "Cover half (of your top) blue and half yellow and you will see green." Of course it may happen that the slight departure from white which will be observed may be in a greenish direction, but it may also be inclined towards pink, or, for anything I know, towards any other colour. The one thing it will not do, however, is to make a green such as is obtained by mixing the pigments, and such as I fancy from the context any one would expect. C. V. B.

The Photography of an Image by Reflection.

THE great utility of spark photography for obtaining time records of quickly-moving objects must be apparent to all who know the experiments of Mr. C. Bell, Prof. Boys, and Lord Rayleigh. By means of spark photography the shadow of any object such as a jet of water, a flying bullet, or a broken soap film can be produced with perfect definition. The shadow of the moving object illuminated by an electric spark is thrown on to a sensitive plate in a dark room, and the plate is developed in the usual manner. The process of spark shadow photography will be found, I believe, of great service in physiological research. With a view to try this I attached a long sensitive plate to the traversing carriage of a chronograph; the moving carriage closed and opened the primary circuit of an induction coil at prearranged equal intervals of time. In front of the moving plate a frog's heart was placed in a slit on a screen; at each break a shadow of the heart was thrown on to the plate by means of the induced spark. By this means thirty positions of the heart were registered; the pictures were all sharp and clear. I have also used the same method for photographing the movements of insects.

Since these experiments which I showed during the University Extension Meeting in Oxford this year, I have made several attempts to get spark photographs of the front view of objects (not their shadows). In my first experiments the objects were illuminated by an electric spark, the image being received on a plate in an ordinary camera. I found that so much useful light was shut off by the lenses that only a dim picture could be produced. A quartz lens was next tried and the results were rather better. I then determined to use no lens, but in its place a silvered mirror. A concave reflector made by silvering a concave lens of about 10 c.m. diameter was so placed that it reflected the image of a white paper star 7 c.m. diameter, revolving about 60 times in a second, on to an ordinary photographic plate, the total length traversed by the light being 80 c.m. The star was illuminated with a spark exactly similar to that used in the previous experiment; on development a good picture of the star came out. The reflector was neither well made nor well silvered. The idea was suggested by observing some spark photographs I obtained of waves on the surface of mercury reflecting light. When a steady light is used a photograph of any object is readily obtained by reflection from a suitable mirror. Probably a steel surface would be best. The mirror and plate were placed in a long box provided with a hole at one end through which the light reflected from the object passed. A few experiments made on living objects to test the time of exposure in Reflection Photography showed that in order to avoid over-exposure, a very rapid shutter must be used.

FREDERICK J. SMITH.

Trinity College, Oxford, October 25.

Induction and Deduction.

As your correspondent invites discussion on this subject I hope you will allow me to repeat in a new form the views I expressed upon it in your columns some months ago. I quite agree with Mr. Russel in maintaining that "true induction is utterly unable to yield us any conclusion that is more than probable and approximate," understanding by induction inference from one or more special cases to a more general rule. But on the other hand it appears to me that Miss Jones's criticism is quite destructive of Mr. Russel's interpretation of geometrical reasoning. The point which both have missed I believe to be this, that a proposition stated in given words, such as the enunciation of Euclid's *pons asinorum* does not always and to every one convey the same information; and if it is meant in one sense its degree of reliability, and the method by which it must be proved, will be quite different from what they would be if it were meant in another. There are at least three different kinds of interpretation which may thus be put upon the proposition. It may mean (1) the triangle used to illustrate this proposition has equal sides; therefore it has equal angles; or (2) I have conceived a triangle which has equal sides, therefore I have conceived one which has equal angles; or (3) the connotation ascribed by the adjective "isosceles" implies the connotation "having equal sides."

It is not necessary for me here to dwell upon the distinction between the first two interpretations; but the difference between either of them and the third is that this latter gives us no information about any real thing or concept, but only about what is implied by using certain terms. And this latter kind of information clearly does not require to be based upon any real knowledge of things, but may be based solely on definitions of words. Arguments with propositions interpreted only in this sense are what I call symbolic arguments; and symbolic conclusions therefore give no real information unless they can be interpreted by the aid of real assertions, such as "I can conceive," or "There actually exist, things possessing the connotations ascribed to these terms by their definitions."

If this distinction has not before been recognized, it is because in most logical discussions we can in this way give a real meaning to our arguments. In elementary geometry, for example, we can—with more or less effort—conceive things, or even actually draw them, which answer to our definitions with sufficient accuracy. And, indeed, the reason why "Euclid"

[1] The purport of the experiment will be best understood if I state that it follows a series of chapters on colour, viz.: the rainbow, the spectrum, its decomposition by refraction and by reflection; while the last chapter discusses and explains, with experiments, the question of spectral lights *versus* pigments. The common surface papers, which the children are daily in the habit of using, are then analysed by the prism, and found to be anything but monochromatic.

and "Newton" are generally considered to yield a more valuable mental training than such subjects as analytical geometry is that the older authors, perhaps because they were a bit afraid of purely symbolic argument, tried constantly to keep real pictures and ideas before the minds of their readers. But even so our conviction of the truth of any but the simplest theorems of geometry depends chiefly on the symbolic argument, not on the realization in succession of the actuality of the relations and operations discussed in the course of the proof. This is perhaps sufficiently obvious in the higher branches of even Euclidian geometry, but it becomes absolutely indisputable when we reach such theorems as "Any two conics in one plane intersect in four points." Not only may some of these points be at an infinite distance, but some, or all, may be what is called, on the *lucus a non lucendo* principle, "imaginary"; that is, they may be such that they cannot be imagined by anybody, much less actually drawn.

Accordingly I cannot admit that the theorems of geometry are established by induction at all. If they are interpreted in either of the first two ways I have described, they are only particular propositions, and the inference from them to a general proposition would no more yield a "mathematical certainty" in this case than in any other. And though the third way of looking at the proposition may be paraphrased into a form which appears general (*e.g.*, anything which may fairly be called "an isosceles triangle" may also be said "to have two equal angles"), it is really only a particular proposition about the words "isosceles triangle," and so on. Its wide applicability and usefulness depends on the fact that we can, and do, often find things which can fairly be called isosceles triangles; but it must be admitted that the assertion that, on any given occasion, we have found such a thing,—is not a mathematical certainty. If the triangle in question is an objective one, we can only say that it is probably, or approximately, isosceles; and though perhaps we may subjectively conceive perfectly isosceles triangles, and so regard the *pons asinorum* as a subjective necessary truth, it must be doubtful whether we could do so in the case of a more complex proposition such as Pascal's Theorem, and it is quite certain that we could not do so in the case of such theorems as that about the intersections of two conics.

It is to be hoped, therefore, that logicians will come to recognize the importance of symbolic reasoning, as mathematicians have already done. And when they do so we may hope for this further advantage, that they in turn will teach mathematicians and others not to confuse a purely symbolic with a real conclusion—not to assume that, because they have correctly proved a conclusion symbolically, that it therefore necessarily gives any information about real things, or even real concepts.

EDWARD T. DIXON.

Trin. Coll., Cambs., October 22.

Bell's Idea of a new Anatomy of the Brain.

IN NATURE of October 27 the writer of the review of Mr. Horsley's "Structure and Functions of the Brain," speaking of the rarity of the above book, states that he only knows of one copy in London, viz., that in the British Museum. It may be useful to some of your readers to know that there is a very interesting copy in the library of the Royal College of Surgeons. It is the presentation copy to Dr. Roget "from Mr. C. Bell, 34, Soho Square": by Dr. Roget it was given to Lady Bell, who presented it to the Royal College of Surgeons through Mr. Alexander Shaw.

Mr. Shaw has added in MS. a copy of the letter received from the printers fixing the original date of publication, and also the list of persons to whom presentation copies were sent. The letter and the list are both published in Mr. Shaw's reprint of the Tract in the *Journal of Anatomy*, vol. iii., 1869.

JAS. B. BAILEY,
Librarian Roy. Coll. Surgeons.

October 27.

Photographic Dry Plates.

IN reference to "Prevention's" note on Photographic Dry Plates, one cannot but agree with him that packets should be dated when issued from the factory.

I would venture, however, to suggest that good makers' plates do not deteriorate within a reasonable length of time.

As an illustration of my experience I may mention that in April this year I opened a box of plates ($\frac{1}{2}$ plate Extra Rapid) which I bought in July 1886.

I had carried them on a three months' tour in the Mediterranean in 1888, and had taken no special care of them since.

They proved in every way as good as new, both in sensitiveness, and perfection and evenness of film.

ARTHUR E. BROWN.

THE GENUS SPHENOPHYLLUM.

NOTWITHSTANDING the small size and comparative scarcity of the plants belonging to this Palæozoic genus, they have long attracted a rather unusual amount of attention. This has been partly due to their peculiar external forms, which suggested even to the earliest observers the idea of resemblances to the Marsiliæ; but the interest they have excited has been further increased of late years by discoveries respecting the peculiar organizations of their stems. In 1822 Adolph Brongniart assigned to them the name of "Spenophyllites," and in 1823 Sternberg figured some of them under the generic title of "Rotularia."[1] Sternberg's figures appeared in his "Versuch einer Geognostisch-Botanischen Darstellung der Flora der Vorwelt," which work is now best known through the French translation of it by Comte de Bray. To the first of his specimens figured (*loc. cit.*, tab. xxvi., figs. 4*a* and *b*), Sternberg gave the name of *Rotularia pusilla*, and the example so designated is very characteristic of the simpler type of the group, in which we have a somewhat branched stem, with verticils of wedge-shaped leaves at each node. A second form was figured on a later plate of the same work. It is interesting to note that Sternberg associated with these figures the observation, "Plantæ organisatione foliorum Marsileis, forma caulis Hippuri Maritimæ." The generic name thus given by this author represents the rotate arrangements of the leaves in each verticil, as the wedge-shaped contour of each separate leaf is further indicated by Brongniart's generic term, "Sphenophyllites." In 1820 Von Schlotheim had also included similar examples in his too comprehensive genus, "Palmacites.[2]"

In 1828 Brongniart published his classic "Prodrome d'une Histoire des Végétaux Fossiles," in which work we find the generic name of these plants changed to Sphenophyllum, which name they have retained to the present time. In this work Brongniart examines in some detail the probable affinities of these plants, which even in 1822 he inclined to regard as having some affinities with the Marsileæ. He defines them as having six, eight, ten, or twelve leaves in each nodal verticil, each leaf being wedge-shaped; sometimes entire, truncated at its apex, which is denticulate. In some others these leaves are bilobed, and in other species they are not only profoundly bifid, but each of these lobes is either divided into two, or their ends are laciniated. Lastly, in some cases the lobes become narrow and linear. Brongniart here compares these leaves with those of Ceratophyllum and Marsilea, concluding with the statement, "We cannot for the moment decide between these two relationships." At this date the fructification was wholly unknown.

In his introduction to the "Natural System of Botany," p. 37, Brongniart again reverts to the idea that Sphenophyllum had Marsileaceous affinities.

In 1831 the authors of the "Fossil Flora of Great Britain" commenced their publication of that work, and in one of its early numbers they figured and described under the name of *Spenophyllum erosum* what appears to be identical with the first figure published by Sternberg. When discussing the relationships of this plant, Lindley and Hutton

[1] These figures were preceded in 1709 by a still earlier one by Scheuchzer in his "Herbarium Diluvianum." (Coemans and Kickx, "Monographie des Sphenophyllum d'Europe").

[2] "Die Petrefactenkunde auf ihrem jetzigen Standpuncte."

reject Brongniart's idea of its possible affinity to the Marsileæ, inclining to the belief that it approached nearer to the Coniferæ, and especially to Salisburia. This impression they retained when, at a later date, they described a second species of the same genus.

In his "Tableau des Genres de Végétaux Fossiles," published in 1849, Brongniart returns to the subject. He here calls attention to the readiness with which Sphenophyllum may be confounded with the genus Asterophyllites, which some forms of the former genus closely resemble; but he again repeats that the two can be distinguished by the fact that in the former genus the leaves never exceed ten in number, whilst their form is triangular with a truncated summit. He again dwells upon the fact that in some Sphenophylla the leaves become so deeply lobed, narrow, and linear, as to be easily mistaken for those of Asterophyllites. He now affirms that the fructification is closely related to that of Asterophyllites.

As to the affinities of Sphenophyllum, Brongniart now asks, "Does the plant combine the leaves of a Marsilea with the verticillate of an Equisetum, or is it a Gymnospermous Phanerogam, the leaves of which approach those of the Gingko?" He does not answer the question, but concludes that this cannot be done until the fructification of the plant is better understood.

In 1864 a monograph on the species of the genus was published by M. Eugene Coemans and M. J. Kickz; but the authors make no serious effort to solve the vexed question of the affinities of the genus.

We now enter upon a new stage in the history of the genus. In 1870, M. Renault presented an important memoir to the French Academy of Science, which, for the first time, threw light upon the internal organization, especially of the stems, of Sphenophyllum. He described two examples, one from Autun and the other from St. Etienne, both of which exhibited a structure wholly different from that of any plant previously known, recent or fossil. In the centre of each stem was a primary vascular bundle, the transverse section of which was a triangle with three concave sides and three prolonged, narrow, intermediate arms. This axial organ underwent no subsequent growth after its first formation. But it was invested by a secondary zone, which was deposited upon the primary triangle layer after layer like a secondary xylem, producing a circular axis, which enlarged as the plant advanced in age. But this secondary growth did not consist of layers of vessels, but of vertical columns of thick-walled cubical cells. The cortex also exhibited specially distinctive features. These discoveries made it clear that Sphenophyllum constituted, not only a very distinct genus, but a type of plant far removed from everything previously described.

It fell to my lot to make the next advances in our knowledge of this genus. In 1871 I described in the memoirs of the Literary and Philosophical Society of Manchester a new fructification, to which further reference will be made later on. In 1872 I obtained from the Oldham deposits some new stems which obviously belonged to the same type as those discovered by M. Renault, but from which they differed in important points of detail. These were described in my Memoir, Part V., published in the Philosophical Transactions for 1874. Transverse sections of these closely resembled in their dominant features M. Renault's corresponding ones, but with two differences. When my plants attained to a certain stage of their exogenous growth, a well-defined circular boundary marked a temporary arrest of that growth, but which started afresh from a zone of much smaller vessels (*loc. cit.* Pl. II., Figs. 11 and 12), that increased in size as the diameter of the axis increased, as they had previously done in the more internal series. Still greater and more important differences presented themselves in the longitudinal sections. The zones of secondary or exogenously developed xylem, which in M. Renault's examples consisted solely of verticolumns of thick-walled, cubical cells, were composed, in mine, of true tracheidal vessels with reticulated (not with bordered pits) walls; presumably a higher stage of development. Another new and more advanced feature than characterise Renault's cells, seen best in tangential sections of this zone (*loc. cit.* Fig. 13), was the existence, between contiguous tracheids, of vertical, but interrupted, series of small cells, which I can only regard as rudimentary medullary rays. In the same memoir (*loc. cit.* Pl. IV.) a still more distinct form from the Burntisland deposits in Fifeshire was figured and described. M. Renault and Count Solms Laubach refuse to recognize a Sphenophyllum in this type, but they have not yet convinced me that I am in error on the point. The fact is that, though widely aberrant from the form described above, it scarcely differs more from that form than the latter does from M. Renault's examples.

But my Oldham specimens raised another debated question. When the Memoir V. was published, all authorities agreed that the maximum number of true leaves in each verticil was ten or twelve; that, however deeply subdivided, their outline was a sphenoid one, and not linear, and that they were multinerved. But I am still convinced that in my specimens there were more than twenty such leaves; that they were linear in outline, and had a single median nerve. It followed that, continuing to accept the existing definitions of the genus Sphenophyllum, my plant was Asterophylloid rather than Sphenophylloid. I am now prepared to admit that it is a Sphenophyllum; but only on the condition that we alter our definitions of the latter genus, and admit the possibility that some of the forms may possess twenty or more undivided and linear leaves. The accumulating evidence that the foliage of at least some of the Sphenophylla was dimorphic makes the acceptance of my proposition a matter of necessity.

Yet more recent researches have revealed new and important facts connected with the history of these plants. I have already alluded to the new fructification which I described in 1871, and to which I gave the name of *Volkmannia Dawsoni*. M. Renault's memoir already noticed was laid before the French Academy in May 1870, and noticed in the *Comptes Rendus* of that date; but owing to accidents growing out of the Siege of Paris, it was not published until three years later. Meanwhile my memoir on *Volkmannia Dawsoni* was published, and a copy of it forwarded to M. Brongniart. After giving details of the structure of the strobilus I arrived at the conclusion that "it is the fruit either of Asterophyllites or of Sphenophyllum."

Two years later M. Renault's memoir of 1870 was combined with a second one on the same subject, and published. It contained a note by M. Brongniart, referring to my memoir of 1871, in which note he says, "This work agrees in many important points with the results obtained a year previously by M. Renault, though Mr. Williamson was unacquainted with the article in the *Comptes Rendus* of May 30, 1870. The fossil plant studied by Mr. Williamson, and named by him *Volkmannia Dawsoni*, doubtless differs, at least specifically, from that described by M. Renault, by the form of the central vascular bundle, and by the absence of the zones of quadrangular cells which surround it in the French specimens; cells which in consequence of the thickness of their walls would not be readily destroyed."[1]

[1] M. Brongniart has here failed to comprehend an important point. The cells, the absence of which he notices, really belonged to the secondary xylem of the older stem, which did not become developed in the youngest twigs. But it was only upon these twigs that the fructifications were formed, and of which they were but extensions. Hence their absence was merely a consequence of difference of age, and not a feature of specific value.

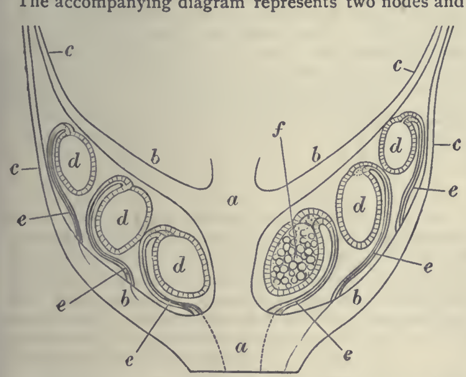
In 1890 I figured in my Memoir XVIII. (Phil. Trans. 1890) a transverse section of what was obviously a stem of *Bowmanites Dawsoni*, in which the primary triangular axis of the strobilus was invested by a thick zone of the secondary xylem. So far as the arrangement of its tissues is concerned this stem is constructed on exactly the same plan as appears in M. Renault's and my own Sphenophylla. In describing it I further said, "We must unite Sphenophyllum with some forms of Asterophyllites in the same genus. It is equally clear that Bowmanites, though its peculiar fructification demonstrates that it constitutes a perfectly distinct genus, has strongly marked features of affinity in the structure of its stem to the Sphenophylloid type."

The above reference to differences between the fructification of Bowmanites and of Sphenophyllum were based upon the minute description of the fruits of the latter plant, published by M. Renault ("Etudes sur le Terrain Houiller de Commentry," pp. 481-2). Those descriptions differ widely from what exists in my Bowmanites, but M. Renault distinctly identifies them with the fructification of Sphenophyllum. I obtained additional and important specimens of Bowmanites in 1890, which threw much new light upon its organization, and which were recorded in my Memoir XVIII. (Phil. Trans. 1891).

In July last an important communication was laid before the Academy of Sciences by my friend M. Zeiller, the distinguished director of the Superior National School of Mines at Paris. In it he records his identification of a fructification of a Sphenophyllum of the type of *S. pusillum* of Sternberg and *S. erosum* of Lindley and Hutton, with my *Bowmanites Dawsoni*. If this determination is correct, and I see no reason for doubting that it is so, we now have some more definite facts than we have hitherto possessed, guiding us alike in identifying the true fructification of Sphenophyllum and in determining its position in the vegetable kingdom.

Before explaining M. Zeiller's observations more in detail, a few words explanatory of the structure of Bowmanites will make M. Zeiller's views more intelligible to the reader.

The accompanying diagram represents two nodes and



one internode from a vertical section of this fruit, with the sporangia and three sporangiophores *in situ*.

So far as external contours are concerned, it is undistinguishable from many of the true Calamarian forms of fructification. It is only when cut into sections that its characteristics can be discovered. Its central axis (*a*) has nodes (*b*) at short and regular intervals, and at each node is a verticil of from 16 to 20 sporophylles or fertile bracts (*c*). At their basal portions these bracts are coalesced into a lenticular disk (*d*), from the margin of which the thinner and narrowing bracts extend upwards, overlapping from two to three internodes. From the upper surface of the disk numerous slender sporangiophores (*e*) spring, each one proceeding upwards and outwards, to become attached to the *upper or distal* extremity of a large oval sporangium (*f*). Each of these sporangiophores has running through it a small bundle of barred tracheids, which terminate at the point of attachment to the sporangium. Each tracheal bundle is a prolongation of one of a circle of similar ones that ascend from the central axis into the disks. These fructifications, besides being manifestly eusporangiate, are extremely characteristic of the plant, nothing identical with them having been observed by any of the authors who have investigated the Carboniferous strobili. After these illustrations I will allow M. Zeiller to explain his views in his own words. After referring to the details given in my Memoir XVIII., M. Zeiller says:—

"L'aspect de ces sporanges, ainsi attachés au bout de ces pédicelles recourbés, est exactement, à part les dimensions moindres, celui de sporocarpes de *Marsilea*. L'analogie parait du reste n'être pas purement superficielle; M. Williamson a reconnu en effet, dans le pédicelle de chaque sporange, un cordon vasculaire bien caractérisé, qui prouve qu'on n'a pas affaire là à une simple formation épidermique, comme pour les sporanges de Fougères ou de Lycopodinées. Il faut, à ce qu'il semble, regarder ces pédicelles comme représentant des lobes ventraux des bractées, analogues au lobe fertile des frondes d'Ophioglossées, ou à ceux des Marsiliacées; seulement ils portent à leur extrémité non pas une série de sporanges comme chez les premières, ou plusieurs sores comme chez ces dernières, mais un sporange unique à paroi formée d'une seule assise de cellules."

"De cette constitution des épis du *Sphen. cuneifolium*[1] il report que, si les Sphenophyllum rappellent les Lycopodinées par la structure de leur axe, ils s'en éloignent notablement par la disposition toute spéciale de leur appareil fructificateur, qui tend à les rapprocher plutôt des Rhizocarpées, et qu'ils doivent donc bien décidément être considéré comme formant une classe distincte parmi les Cryptogames vasculaires."[2] Agreeing thoroughly with these conclusions further comments are needless.

WM. CRAWFORD WILLIAMSON.

DENDRITIC FORMS.

THE curious appearances presented by certain native specimens of silica have been observed for so long, that it is somewhat surprising that so little is known about their real constitution and mode of formation.

Rock-crystal is frequently found to contain bubbles of liquid, usually either water, carbon dioxide, or petroleum, or crystals, such as scales of mica, forming aventurine, and fibres, such as asbestos, forming cat's-eye. More rarely, however, forms of apparently vegetable origin are seen; one of the most remarkable specimens is a prolate spheroid, about five inches long and four inches across, cut from a clear colourless rock-crystal, in which are embedded numerous fragments about the size of a large pea, presenting the exact appearance of club-moss.

Agate is frequently found with distinct coloured layers, either flat or distorted, and usually milk-white, red, brown, or black. It is then known as onyx.

More rarely, agates are found with markings like moss or foliage distributed through them; they are then known as moss-agates, or Mocha stones.

In 1814, Dr. J. MacCulloch described some cryptogamic forms in the agates of Dunglas (Geological Trans., ii.,

[1] The species of Sphenophyllum to which M. Zeiller's strobili were attached.

[2] *Comptes Rendus des Séances de l'Académie des Sciences*, Paris, July 11, 1892.

iv., 398). It is stated that the Earl of Powys possesses an onyx containing the chrysalis of a moth.

It seems to be generally assumed, without any strong evidence, that rock-crystal and agate have been formed from solution in water, possibly superheated, and that in such cases as those mentioned above, various crystalline or fibrous minerals and low forms of plant life have been inclosed during the process of solidification.

Though this explanation is very possibly true in many cases, it does not account for all the appearances seen in moss-agates; and another possible mode of formation may be suggested by a brief account of some experiments made more than twenty years ago.

Ordinary crystals of ferrous sulphate dissolve readily in cold water; but if they are placed in a dilute solution of an alkaline silicate, an entirely new series of phenomena are produced, which were first described by J. D. Heaton, M.D., in a paper "On certain Simulations of Vegetable Growths by Mineral Substances" (Brit. Assoc. Report, 1867, p. 83). On immersing crystals of ferrous sulphate in a solution of sodium silicate of the density 1·065, very beautiful arborizations will soon begin to shoot perpendicularly upwards, attaining the height of three or four inches in a few hours. In a weaker solution roots can be caused to shoot downwards from a suspended crystal. The fibres contain silica and iron (less the weaker the solution); they are brittle, and more dense than the liquid in which they are formed. Examined by the microscope, the ultimate ramifications are cylindrical, tapering tubes, the walls of which are granular, showing no sign of crystallization. The roots are more abrupt and occasionally club-shaped in their terminations. The growth is interstitial like that of organized living tissue. "Supposing such purely mineral substances to have been formed in by-gone geological eras, and to have been accidentally fossilized in some primary or other ancient rock, they would very probably, when discovered by recent investigation, be pronounced to be an evidence of organized beings having existed contemporaneously with the formation of such rock."

In the following year a similar observation was made by Prof. W. C. Roberts-Austen (J. C. S., 1868, xxi., 274). A solution containing 4·9 per cent. of silica, when allowed to gelatinize, and dried for two days over sulphuric acid, left a solid residue similar to opal from Zimapan, but containing 21·4 per cent. of water. All the specimens of jelly dried in air contained dendritic forms, varying in size from 0·2 to 0·5 mm. When magnified 90 times they appeared as radiating fibres; when the power was increased to 700 times linear, each fibre resolved itself into a series of elongated beaded cells with clusters of circular cells at intervals. Mr. Slack indicated their remarkable analogy to common blue mould or mildew. The cells appeared to be hollow, and did not blacken with sulphuric acid.

A few years later I repeated Dr. Heaton's experiments, and made some additional ones, a brief account of which may induce some one with better means at his disposal to investigate an interesting and somewhat neglected subject.

If a crystal of copper sulphate be suspended in a solution of potassium silicate, which has been carefully neutralized and has a density of 1·065, in the course of a few minutes a hollow green column will be seen to run down from the crystal to the bottom of the beaker. Sodium silicate may be used instead of potassium silicate, but the appearance and rapidity of the growth is somewhat changed. The solution may be neutralized with hydrogen sulphate, chloride, or acetate, but hydrogen fluoride appears to prevent all growth. If the solution has a density less than 1·06, no growth occurs, and the crystals generally dissolve; the weaker the solution down to this limit the more rapid the growth. If the solution be stronger, the time required for the growth to commence may be lengthened from minutes to many days. If the density be above 1·25, no growth takes place.

Copper sulphate gives the best results, but it may be replaced by ferrous, manganous, or nickel sulphate; with changes in the shape, and of course in the colour, of the growths. The growths take place most readily from a clean sharp crystal, and always from an angle or edge; an edge obtained by cleavage requires more time. Other salts besides the sulphates may be used, but do not act so rapidly, probably owing to less perfect crystallization of the specimens used.

In a neutral or very feebly alkaline solution the growths are comparatively rapid, and consist of long, branching, tapering fibres, not unlike the roots of a tree. They grow rather more rapidly downwards than upwards. If the solutions be decidedly alkaline, the growths are much slower, and consist of fine stalks with comparatively large lumps at the extremities.

The tubes seem to be composed of silica with a small proportion of the metal used; they differ much in colour, are more dense than the liquid in which they grow, and are insoluble in water or dilute acids. When magnified 100 times, the substance of the tube shows no appearance of crystalline form, but seems to consist of concretions of ovoid granules. In this particular it differs from the substance of lead or silver trees, and from the curious fibres of potassium, iodide, and chloride described by Mr. Warington (J. C. S., v., 136, viii., 31).

It is generally assumed that the formation of onyx is due to the successive deposition of layers of silica coloured by different substances, but the following experiment suggests another possible method of formation, especially when the extreme permeability of gelatinous silica by liquids is remembered. So readily are even the hardest agates permeated by hot aqueous solutions of salts, that "staining" is a common commercial process.

A little too much sulphuric acid was accidentally added to a moderately strong solution of potassium silicate in which some crystals of copper sulphate were lying. The copper sulphate dissolved, and the solution set to a uniform blue jelly. After standing for about a week, the blue colour at the top of the jelly had separated into a series of thin parallel coloured plates, leaving the jelly between them colourless. This curious separation of the colouring-matter gradually proceeded downwards, and reached the bottom of the precipitating glass in about a month. The jelly gradually shrank, dried, and hardened, forming fragments consisting of blue bands in a white mass.

Sydney Lupton.

NOTES.

There will be a memorial celebration for A. W. von Hofmann on November 12, arranged by the Deutsche Chemische Gesellschaft, at Berlin on the 25th anniversary of its foundation. The Empress Frederick and many German and foreign celebrities have been invited to be present. The proceedings, which will take place at the Berlin Town Hall, will include speeches on the history of the Society and on Hofmann, a review of progress in chemical science by Hr. Wislicenus, and choral music, performed by the members of the cathedral choir.

We regret to have to record the death of Mr. Robert Grant, F.R.S., Professor of Practical Astronomy at the University of Glasgow. He died at Grantown-on-Spey, his native place, at the age of seventy-eight.

The death of Dr. Löwenherz, director of the Imperial Physical Institute, Berlin, has been announced. He died at Berlin on Sunday last.

Prof. Virchow has been appointed an honorary member of the Imperial Russian Natural Philosophy Society.

AN international ethnographical exhibition is to be held next year in St. Petersburg. It will be organized by the Russian Geographical Society.

THE American Microscopical Society offers prizes for the encouragement of microscopical research, two of the value of 50 dollars each, and two of the value of 25 dollars each, for the best papers which shall give the results of an original investigation made with the microscope, and relating to animal and plant life respectively; also two of the value of 30 and 15 dollars respectively for the best six photomicrographs in some subject of animal or vegetable histology; and two of the same value for the best collections of six mounted slides illustrating some one biological subject.

IN a letter to the *Times* on scientific titles and their abuse Prof. Tilden has opened a subject of considerable interest to men of science. It is well known that the letters indicating membership of a society are sometimes used by persons who have no right to use them, and Prof. Tilden notes that an effort is to be made to deal with this evil by getting a Bill before Parliament "for the purpose of securing to the respective societies the copyright of these letters." This, however, is a comparatively unimportant aspect of the question. The real difficulty is that membership of scientific societies is frequently "represented in courts of law or by candidates for public appointments as evidence of professional trustworthiness," whereas in very many cases it does not at all necessarily imply any extensive or accurate knowledge of the subjects in which the societies are especially interested. "Fellowship of the Royal Society, indicated by the letters F.R.S.," says Prof. Tilden, "is a real distinction which is justly prized. But what is the public to understand regarding such alliterations as F.B.S., F.C.S., F.E.S., F.G.S., F.L.S., F.S.S., F.Z.S., and of F.S.A., M.R.I., F.R.A.S., F.R.M.S., F.R.G.S., F.R.S.E., &c.? With the exception of one or two of the societies represented here, admission is to be gained by almost any one who is willing to pay the customary contribution to the funds of the society, and who can get two or more members of the society to testify to his fitness for admission, which generally means respectability and a profession of interest in the subject, the cultivation of which is the object of the society." He adds that if the public knew all about the societies no harm would arise; but "judges and barristers, and county councillors and town councillors cannot be expected to have this knowledge." Prof. Tilden thinks that "the only chance for a better state of things is for every member of these societies who respects himself to abandon the use of these unmeaning letters altogether"; but he fears that there is very little prospect of such a general reform while "an Institute having for its president no less a person than the Heir Apparent to the throne condescends to bait its advertisements for subscribers with the offer of more letters. The *Times*, discussing the subject in a leading article, expresses the opinion that in the main "we must trust, imperfect though the security is, to the ability of grown-up men and women to protect themselves against a form of deception which has most hold over those who themselves covet the meaningless letters to which they blindly pin their faith."

THE weather during the past week has been characterized by a marked increase of temperature and excessive rainfall, accompanied by strong southerly winds and gales. Between Wednesday the 26th and Friday the 28th October, the temperature in parts of England increased upwards of 30°, while the air became very humid and unpleasant. The continuance of comparatively high temperature, during which the thermometer reached 60° in the central and southern parts of the kingdom, was due to the track of the depressions, causing a continual indraught of warm air from off the Atlantic. On Thursday the 27th ult., about $1\frac{3}{4}$ inch of rain was measured in the West of Ireland, and heavy falls occurred on the following days in the Midland counties. A further downpour, amounting to $1\frac{1}{2}$ inch in the Channel Islands, and to 1·3 inch in London, occurred on Sunday night, and the amount which has fallen on the east coast of Norfolk during the month of October is about equal to three times the average. During the first part of the present week, the disturbance which caused the heavy rainfall passed away, and a small area of high pressure temporarily advanced over the United Kingdom from the Atlantic, while the temperature fell several degrees, with mist or fog in places; but conditions were very unsettled, and a change of wind to the south-eastward in Ireland gave indications of probable further disturbances. During the week ended the 29th ultimo, the amount of bright sunshine exceeded the mean in nearly all districts.

THE Meteorological Council have recently issued a summary of the *Weekly Weather Report* for the quarter ending September 1892, which shows the rainfall and mean temperature in each district for each similar quarter for the twenty-seven years 1866–92, grouped in five yearly averages, and also the means for individual years from 1881. The average rainfall of the quarter for the whole of the British Islands was 10·2 inches, or only 0·7 inch in excess of the mean for the whole period. This result is almost entirely due to an excess in the grazing or western districts, amounting to 1·5 inch, while in the wheat-producing or eastern districts the fall for the quarter is slightly below he mean. The temperature for the quarter has been below the mean generally; for the whole of the country the deficiency amounted to 1°·8, and was 1°·7 in the grazing districts and 1°·9 in the wheat-producing districts. Similar returns show that the excess of rainfall amounted to 1·5 inch in the same quarter of 1891, prior to which there had been a series of seven dry quarters, while the temperature has been uniformly below the mean for six corresponding quarters. The coldest quarter was in 1888, when the deficiency amounted to 2°·5, this being, in fact, the coldest corresponding quarter during the last twenty-seven years.

THE late Mr. George Grote, the historian of Greece, expressed in writing, eight years before his death, a desire that after his decease his cranium should be opened and his brain weighed and examined. The task was undertaken by the late Prof. John Marshall, and the results of his observations are set forth in a full report printed in the current number of the *Journal of Anatomy and Physiology*. The entire encephalon was somewhat above the average in size, if compared with the adult male brain at all ages. If allowance be made for the effects of senile wasting, it must be regarded as a rather large brain, but not as an actually or especially large one. There can be no doubt, however, that it was, at death, further diminished in size and weight through the effects of disease, as shown by its marked deviation from the ordinary ratio as compared with the body-weight. As tested by the standard of macrocephaly adopted by Welcker, its utmost allowable weight was below that standard; and as contrasted with the encephala of certain other eminent men, it would find its place about one-third up from the lower end of the list. The general form of the cranium was rather or nearly brachycephalic, but it was decidedly higher than usual. The cerebrum itself was, in accordance with the shape of the cranium, short, broad, and deep. The cerebral convolutions were very massive, being not only broad and deep, but well folded, and marked with secondary sulci. This condition was observable all over the cerebrum, but chiefly remarkable in the frontal and parietal regions. Studied in reference to Dr. Ferrier's researches into the localization of function in the brain, the relative size of certain convolutions or groups of convolutions suggested some reflections as to individual peculiarities, but these reflections did not seem to Prof. Marshall

to be quite trustworthy. From the size and richness of the convolutions, the sufficiency of the grey matter both on the surface and in the interior of the hemispheres, and from the remarkable number of the white fibres, especially of the transverse commissural ones, the brain of Mr. Grote is pronounced to have been of very perfect and high organization.

The method of cleaning mercury adopted at the Physikalisch-technische Reichsanstalt at Berlin is described in the *Zeitschrift für Instrumentenkunde.* The raw material is brought in iron bottles from Idria. It is filtered and dried, and twice distilled in a vacuum to get rid of the heavy metals. Great care is taken to eliminate fatty vapours derived from greased valves and cocks, which is accomplished by means of a mercury pump working without a stopcock. Finally, the electro-positive metals, such as zinc and the alkalies, are separated by electrolysis. The mercury is precipitated from a solution of mercurous nitrate obtained by the action of nitric acid on excess of mercury. The solution, together with the impure mercury acting as an anode, is contained in an outside glass vessel, into which a current from a Gülcher thermopile is conducted by an insulated platinum rod. The cathode rod dips into an interior shallow glass vessel, in which the pure mercury is collected. On careful analysis it was found that no perceptible non-volatile residue was left by 200 grammes of the purified metal. Thus the mercury is well fit for use in standard barometers and resistances.

With regard to the revival of animals after exposure to great cold, Herr Kochs (in the *Biologisches Centralblatt*) points out two things which retard formation of ice in the animal body. First, the body does not contain pure water, but salt and albumen solutions, which only freeze under zero C. Then capillarity and adhesion hinder freezing. Herr Kochs states that water in a glass tube of 0·3 to 0·4 mm. diameter may be cooled to $-7°$ and even $-10°$ C. without freezing. With a diameter of only 0·1 to 0·2 mm. the water is not frozen, even though the end of the tube be put in freezing liquid. Thin liquid sheets between two glass plates behave in the same way. If a salt solution freezes, the salts are excluded; and pure water, in freezing, gets rid of its absorbed gas. Fresh blood, according to the author's experiments, freezes only after being strongly cooled to $-15°$C., and after complete elimination of gases and salts. The blood corpuscles are dissolved and the blood loses colour. The same elimination doubtless occurs in freezing of protoplasm. Experiments cited to show the possibility of "anabiosis" may probably be explained by the decomposition process not having gone so far as to bring life completely to a standstill. Similar results were obtained in experiments on drying of seeds and various animals. It was shown with what tenacity many animals, under most unfavourable circumstances, retain the moisture necessary to life.

The very destructive American disease of the vine known as the "Black-rot" has, for some years past, made its appearance in Europe, and its life-history has now been thoroughly investigated by Viala, Ráthay, and others. The ravages of the disease have been traced to a parasitic fungus, *Læstadia Bidwellii*, the mycele of which develops in the interior of the organ attacked, chiefly the young branches and berries, and produces spermogones and pycnids in the course of the summer. It is especially by the pycnospores that the fungus is disseminated. Towards the end of the period of vegetation sclerotes are formed, usually within the pycnids, and the conidiophores spring from these. Peritheces are also formed in May and June on the fallen and infected berries of the previous year. Until recently the ravages of this pest in Europe were confined to the French vineyards, but it has recently been detected in Austria and in Italy. The most effectual remedy for it is salts of copper.

The results obtained from the botanical work done at the various experiment stations in the United States will in future be published in the form of an "Experiment Station Record," issued by the Department of Agriculture, under the editorship of Mr. Walter H. Evans.

Anglo-Indian papers record the presentation of an interesting "piece of architecture" to the Madras Central Museum by Lord Wenlock. It is a hornets' nest, belonging probably to the species *Vespa cincta.* It is conical in shape, and is constructed of a material resembling rough paper or cardboard composed of woody portions of plants gummed up by the insects, and brought into the condition of paste by means of a viscid salivary secretion. The combs are placed in tiers and attached to each other by small columns of the same paper-like material of which the nest is composed. It is two feet in height, and about the same in circumference at the base. It was obtained in the course of one of His Excellency's tours.

M. de Nadaillac, in the current number of *La Nature*, discusses the significance of some of the facts which have been brought to light by the recent excavations of mounds in the Ohio Valley. The mound builders knew how to construct earth fortifications, which were of considerable extent and always remarkably adapted to the sites chosen. They buried their dead under tumuli of astonishing dimensions. Copper was the only metal they could work, and they undertook long journeys in search of it. Their weapons and implements were of stone. They made vases of pottery, and were able to produce representations of the human figure and of animals, both by sculpturing them in stone and by modelling them in clay. At least in some districts they were sedentary, and, like all sedentary populations, they had to obtain the means of subsistence in part by cultivation of the soil. They were often engaged in fighting, and numerous burials in which the bodies are crowded together bear witness to the fury of their struggles. Whence did they come and who are their descendants? M. de Nadaillac thinks that these questions can never be definitely answered unless investigators discover some traces of the language of the mound-builders.

An interesting and valuable paper on the association of shipping disasters with colour-blind and defective far-sighted sailors, read by Dr. T. H. Bickerton before the section of Ophthalmology at the last annual meeting of the British Medical Association, has been reprinted for the author from the *British Medical Journal.* Dr. Bickerton takes anything but a hopeful view of the prospects of legislation on this important question. He greatly fears that "many a shipping disaster will occur before the Royal Society's suggestions become part of the law of the land." Accordingly he urges all who interest themselves in the subject to abate not a tittle of their endeavours. "There are none," he says, "so difficult to convince as those who will not believe, and the men who have had the framing of the rules of the road at sea are the very men who hitherto have turned from all suggestions on the eyesight question with contempt. True it is that their language, judged from examples to be found in the *Nautical Magazine*, is becoming moderate, and even polite, but they lack knowledge of this subject, and they will still require our best attention." Meanwhile, Dr. Bickerton presses on the attention of the public the following facts:—that 4 per cent. of the whole male population are colour blind; that about 8 per cent. more have marked impairment of sight from refractive errors; that there is no official test whatever as to a sailor's eyesight; that a man may be the subject of any of the forms of eye disease, may have any degree of blindness, or may be so short-sighted as to be unable to see distinctly more than a few inches in front of his nose, and yet be at perfect liberty to be a sailor and to become an officer; and that, although there is a

compulsory colour examination (in many cases a most inefficient one) to be passed before a sailor can become an officer, there is no check to a colour-blind man being a sailor, or to his remaining one to his life's end.

THE Rev. T. A. Marshall describes in the November number of the *Entomologist's Monthly Magazine* a new genus and species of Belytidæ from New Zealand. The paper is accompanied by representations of two insects in fine condition. Mr. Marshall abstains from giving tedious details, as the figures will, he believes, convey a better idea of these creatures than many words, and he thinks they will now be unmistakable, at least until other species of the same genus shall be discovered. He has not taken any characters from the under-side, the specimens being carded; hence the oral organs could not be described, but they may be pretty safely assumed to resemble those of *Belyta*, *Anectata*, &c., and their details would have been of little value.

A CORRESPONDENT of the New York journal *Electricity*, writing from Paris, describes some electrical peculiarities which he has seen in a cat. This cat, called Michon, is a half wild animal, and dislikes handling. It belongs to the household of Dame Gais, whose residence on the Carnier Mount, near Monte Carlo, looks directly down on the noted gambling casino and its botanical reservation. On some of the cold and very dry nights common to Monte Carlo in the winter, Michon, while in the dark, is quite a spectacle. Every movement of its body sends off hundreds of minute bluish sparks, something like those thrown off by ill-adjusted brushes, though not so pronounced in colour. They make a noise on a small scale, like the crackling of burning furze. Stroking the cat increases the sparking, and ruffling its fur the reverse way produces a miniature pyrotechnic display quite remarkable. The cat itself does not seem to mind the sparking, but, like all cats, dislikes to have its fur rubbed in a wrong direction. The writer has never seen the electric element so abundant in a cat, and many who have seen the coruscations that have given notoriety to Michon, confirm him in the opinion that the cat is an electrical curiosity.

A USEFUL account of "Biological Teaching in the Colleges of the United States," by Prof. John A. Campbell, of the University of Georgia, has been issued by the United States Bureau of Education. The writer's object is to present the actual extent and scope of the biological courses offered by the colleges of the United States, together with the methods of teaching employed. He also aims at presenting as fully as possible an account of the equipment and facilities for teaching which the various colleges possess. The statements he makes are therefore based largely upon the printed accounts found in the college catalogues, supplemented in many cases by letters containing additional information. These have usually been re-written, but where they are in suitable form they are quoted directly. Prof. Campbell notes that many of the colleges announce more in their catalogues than they can possibly do thoroughly with the teaching force employed. This is often perfectly apparent, but in more than one letter received the statement has been made that certain courses have no existence save on paper. Prof. Campbell, however, thinks that it is worth while to record the views of the professors in charge in regard to the nature and aims of such work, and the ideals towards which they are striving.

THE "Treatise on Hygiene and Public Health," edited by Dr. T. Stevenson and Mr. Shirley Murphy, and reviewed in NATURE last week, is published by Messrs. J. and A. Churchill.

MESSRS. J. AND A. CHURCHILL are publishing a second edition, revised and enlarged, of "Commercial Organic Analysis," by Alfred H. Allen. The second part of the third volume has just appeared. The third part of the same volume will be issued as soon as possible, and will complete the work. In the second part he has sought to describe fully and accurately such of the organic bases as have any practical interest, and to give trustworthy information as to their sources.

THE new number of *Natural Science* includes articles on the evolution of consciousness, by C. Lloyd Morgan; primæval man: a palæolithic floor near Dunstable, by W. G. Smith; the evolution of sharks' teeth, by A. S. Woodward; the walk of arthropods, by G. H. Carpenter; the falling of leaves, by A. B. Rendle; and Norwich Castle as a museum, by H. Woodward.

A REVISED edition of "London Birds and London Insects," by Mr. T. Digby Pigott, has been issued by Mr. H. Porter. Along with the essays on these subjects have been printed several other bright and attractive sketches.

AN elaborate index to the genera and species described in the "Palæontologia Indica," up to the year 1891, by W. Theobald, has just been issued. It is included among the Memoirs of the Geological Survey of India. Mr. Theobald has also prepared "Contents and Index of the Memoirs of the Geological Survey of India, 1859 to 1883."

A SECOND edition of Dr. F. H. Hatch's "Text-book of Petrology" has been issued by Messrs. Swan Sonnenschein and Co. The author explains that he has taken advantage of this opportunity to revise the book thoroughly, while largely increasing its scope.

THE Society for Promoting Christian Knowledge has published a second edition of Klein's "Star Atlas." Mr. E. McClure, the translator of Dr. Klein's explanatory text, has sought to bring up to date the German writer's descriptions of the more interesting fixed stars, star clusters, and nebulæ.

MESSRS. ROBERT GRANT AND SON, Edinburgh, and Messrs. Williams and Norgate, London, have issued Parts II. and III. of Vol. XXXVI. of the Transactions of the Royal Society of Edinburgh. The following are the subjects of some of the papers:—the foundations of the kinetic theory of gases (IV.), by Prof. Tait; the solid and liquid particles in clouds, by J. Aitken; the development of the carapace of the chelonia, by J. B. Haycraft; the composition of oceanic and littoral manganese nodules, by J. Y. Buchanan; the winds of Ben Nevis, by R. T. Omond and A. Rankin; and the Clyde sea area, by H. R. Mill.

THE University College of Wales, Aberystwith, has issued its calendar for its twenty-first session, 1892–3.

THE City and Guilds of London Institute has issued its programme of technological examinations for the session 1892-93.

MESSRS. GEORGE PHILIP AND SON announce that a work on "British New Guinea," by Mr. J. P. Thomson, Hon. Sec. to the Brisbane Branch of the Royal Geographical Society of Australasia, is almost ready for publication. An appendix will contain contributions to the geology, fauna, flora, &c., by Sir William Macgregor, K.C.M.G., Baron Ferdinand von Mueller, Professor Liversidge, F.R.S., and others. The proof-sheets have been revised by Dr. H. Robert Mill and Dr. Bowdler Sharpe.

ANOTHER and apparently much more convenient mode of preparing glycol aldehyde, $CH_2OH.CHO$, the first member of the series of aldehyde-alcohols, is described in the current number of the *Berichte*, by Drs. Marckwald and Ellinger, of

Berlin. It may be remembered that in our note of a fortnight ago (vol. 46, p. 596), it was announced that Prof. Emil Fischer and Dr. Landsteiner had succeeded for the first time in preparing this interesting substance in a state of tolerable purity by a reaction analogous to that of barium hydrate upon acrolein dibromide, the reaction which yielded the first synthetical glucose. They first prepared the mono-bromine, derivative of common aldehyde, $CH_2Br.CHO$, and subsequently reacted upon this new substance, a liquid possessing an intolerably sharp odour, with baryta water. After removal of the baryta by sulphuric acid, and the hydrobromic and sulphuric acids by means of carbonate of lead, a liquid was obtained which possessed the properties of a dilute solution of glycol aldehyde. Some time ago Pinner obtained a derivative of this aldehyde which bore the same relation to glycol aldehyde, that the compound known as acetal, $CH_3.CH\left\langle\begin{matrix}OC_2H_5\\OC_2H_5\end{matrix}\right.$, bears to common aldehyde. This substance, glycol acetal, $CH_2OH.CH\left\langle\begin{matrix}OC_2H_5\\OC_2H_5\end{matrix}\right.$, Pinner attempted to decompose, by the action of mineral acids, into ethyl alcohol and glycol aldehyde. The attempt, however, did not succeed, inasmuch as the decomposition went further, any glycol aldehyde that may have been formed during the first stage of the reaction being subsequently broken up. Drs. Marckwald and Ellinger now find that the reaction succeeds admirably, provided the acid employed is extremely dilute, and as glycol acetal is a substance very easily prepared, they show that the reaction affords a very convenient and advantageous method of preparing large quantities of glycol aldehyde. The glycol acetal is added to an equal volume of water acidified with only a few drops of sulphuric acid. The liquid is then heated to boiling. After a short time the two liquids mix, and the reaction is completed when upon the addition of water to a few drops of it no separation of oil occurs. Upon distilling the liquid product, alcohol first passes over, then there distils a mixture of water and glycol aldehyde until decomposition of the residue commences. Glycol aldehyde, as thus obtained in a tolerably concentrated form, appears to be much more volatile in steam than was observed by Prof. Fischer and Dr. Landsteiner, in case of their more dilute solutions. From a few cubic centimetres of the distillate Drs. Marckwald and Ellinger obtained a very considerable quantity of Prof. Fischer's phenylhydrazine compound, and confirm in every detail the other properties of glycol aldehyde described in our previous note above referred to. The chemistry of this first member of the series which includes the sugars is now, therefore, fairly complete, and the difficulties in the way of its preparation surmounted.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus* ♂) from India, presented by Mr. Pascoe Grenfell, F.Z.S.; a Philantomba Antelope (*Cephalophus maxwelli*) from West Africa; three Gambian Pouched Rats (*Cricetomys gambianus*) from West Africa; a Ground Rat (*Aulacodus swindernianus*) from West Africa; and a White-faced Tree Duck (*Dendrocygna viduata*) from West Africa, presented by Mr. C. B. Mitford; a Martial Hawk-Eagle (*Spizaetus bellicosus*) from South Africa, presented by Mr. T. White; two Weaver Birds (*Hyphantornis sp. inc.*) from South Africa, presented by Mr. A. W. Arrowsmith; two Silver Pheasants (*Euplocamus nycthemerus* ♂ ♂) from China, presented by Mr. E. Mitchener; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Miss Kate Higgins; a Thick-tailed Opossum (*Didelphys crassicaudata*) from South America; a Garden's Night-Heron (*Nycticorax gardeni*); and two Saracura Rails (*Aramides saracura*) from South America, purchased; and a Squirrel Monkey (*Chrysothrix sciurea*) from Guiana, deposited.

OUR ASTRONOMICAL COLUMN.

COMET BROOKS (AUGUST 28).—The following ephemeris, which we take from *Astronomische Nachrichten*, No. 3125, gives the apparent Right Ascensions and Declinations of Comet Brooks, which is brightening very rapidly:—

12h. Berlin M.T.

1892.	R.A. app. h. m. s.	Decl. app. ° ′	Log. *r*.	Log. Δ.	Br.
Nov. 3	9 23 51	+9 55·8			
4	27 50	9 9·8	0·1265	0·0225	11·60
5	31 51	8 22·7			
6	35 55	7 34·6			
7	40 1	6 45·4			
8	44 10	5 55·2	0·1125	0·0034	13·51
9	48 21	5 4·0			
10	52 34	4 11·8			

Lying in the extreme northern corner of the constellation of Sextans, and nearly midway between ρ Leonis and ε Hydræ, it will not be an easy object for observation owing to its very late rising.

COMET BARNARD (OCTOBER 12).—Prof. R. Schorr, of Hamburg, communicates to *Astronomische Nachrichten*, No. 3125, the elements and ephemeris of Comet Barnard, deduced from observations made on October 16, 18, and 20, at Vienna, Hamburg, and Pulkowa respectively. As this ephemeris differs rather considerably from the one we gave last week, the following places may prove of service to observers:—

12h. Berlin M.T.

1892.	R.A. h. m. s.	Decl. ° ′	Log *r*.	Log Δ.	Br.
Nov. 3	20 24 38	+5 3·7			
4	27 20	4 44·0			
5	30 4	4 24·6	0·2298	0·1539	1·00
6	32 48	4 5·4			
7	35 34	3 46·4			
8	38 21	3 27·8			
9	41 9	3 9·4	0·2278	0·1590	0·99
10	43 58	2 51·2			

This comet will still be found to form approximately an equilateral triangle with α Aquilæ and β Delphini on November 5.

TABULAR HISTORY OF ASTRONOMY TO THE YEAR 1500 A.D.—Dr. Felix Müller, of Berlin, has just completed a small volume entitled "Zeittafeln zur Geschichte der Mathemathik, Phisik und Astronomie bis zum Jahre 1500," which will be welcomed by all interested in the very early history of the exact sciences. The book is arranged chronologically and gives a short account of the chief workers in these branches of science up to the year 1500. At the end of each reference a list of the literature likely to be needed is added. The work is published by Messrs. B. G. Teubner, Leipzig.

A LARGE TELESCOPE.—The Americans seem to have made up their minds to be the possessors of the largest telescopes in existence, for in spite of their owning the great Lick Refractor (36-inch) we hear now that the University of Chicago are about to have "the largest and most powerful telescope in the world." This instrument will be the gift of Mr. Charles Jerkes, and will cost half a million dollars. The object-glass will have a diameter of 45 inches and will be made by Messrs. Alvan Clark, of Cambridge, Mass.

THE ATMOSPHERES OF PLANETS.—Of all the planets that revolve round our sun, Jupiter affords the most suitable of them for the study of atmospheric circulation. That his circulation will not be exactly like ours will be at once evident, for not only does the sun pour his rays on his vast surface, but he possesses himself heat, as is suggested by the rapid changes which these cloud masses undergo. A recent hypothesis, explaining the various movements in this planet's atmosphere, has been put forward by Mr. Marsden Manson, in the fifth number (vol. ix.) of the "Transactions of the Technical Society of the Pacific Coast," San Francisco. The chief element which produces these movements is the action of the sun, and it is on this reasoning that he attempts to unravel the laws underlying the circulation in Jupiter's atmosphere. In this pamphlet he first brings together some of the facts relating to our own wind system, which are generally conceded, together with the important results that were gathered from the path taken by the Krakatoa

dust-cloud. The spots observed on Jupiter's surface are next dealt with, a table of their rotation periods and latitudes being included. From the latter he deduces that the mean periods of rotation of matter in the following latitudes are:—

Lat.		h.	m.	s.
12° N. from 17 N.	Temp. spots	9	55	36·49
4° N. ,, 5 N.	Equat. ,,	9	50	40·06
8° S. ,, 21 S.	Equat. ,,	9	50	22·4
30° S. ,,	3 spots	9	55	17·1

In treating of the spots themselves, he suggests that those which are of a white appearance are gyrating uprushes of warm air from the lower regions, while the dark ones are simply descending columns of cool air, "the two forming parts of the system of vertical circulation." The red spot, he suggests, is caused by a local escape of internal heat, the repellent force it appears to possess being due to the "spreading of the heated currents as they rise." He explains the retardation and acceleration of its period of revolution by the increasing force of the west winds, brought about by the exposure of the southern hemisphere during Jupiter's half-year (5·93 of our years); in this way the spot is sometimes situated over and sometimes to one side of the source of heat underneath. The author also deals with other spots in a similar manner.

GEOGRAPHICAL NOTES.

MR. SVEN HEDIN'S account of his ascent of Mount Demavend is published in the last number of the *Verhandlungen* of the Berlin Geographical Society. Demavend is a volcanic peak rising abruptly from the sedimentary rocks of the parallel Elburz chains. Starting from the village of Ranah on the south-eastern slope with two guides on July 10, 1890, Hedin reached the summit on the afternoon of the next day. On the summit a large elliptical crater was found; the edges of which were strewn with blocks of porphyritic lava and sulphur. After discussing the aneroid and boiling point observations, Mr. Hedin arrived at 5465 metres (17,930 feet) as the height of the summit. This is lower than any of twelve earlier estimates which are cited, the highest of them being 6559 metres.

THE Italian possession of Eritrea on the coast of the Red Sea gives some promise of becoming useful agriculturally. Several small settlements of Italians on the plateau have succeeded in growing large crops of wheat and barley, and only the unsettled state of the surrounding natives threatens the prosperity of the farmers. The districts of Oculé-Cusai and Guro are already fully cultivated, and Saraé, as yet almost unoccupied, has fertile land and plenty of room for colonists. The Italians are able to work in climatic conditions which would rapidly exhaust the natives of northern Europe.

THE general summary of Mr. Conway's expedition in the Karakoram range telegraphed from India (p. 525) has now been supplemented by a full narrative, written to the secretaries of the Royal Geographical Society from a camp on the Baltoro Glacier on August 29, with a postscript added at Skardo, on the way to Leh, on September 12. The difficulties of the preliminary journey were very great, not the least being the fording of several swollen glacier streams by a party numbering four Europeans, four sepoys, seventy coolies, an indefinite number of followers, and flocks of goats and sheep. The moraines on the Baltoro glacier were of almost incredible extent; for two-thirds of its entire length the ice is entirely concealed by stones, except where crevasses or lakes occur, and the irregularity of the surface made travelling extremely slow. Mr. Conway limits the name of Godwin-Austen to the highest peak of "K²," giving to the whole mountain the somewhat cumbrous title of the Watch Tower of India. One branch of the Baltoro Glacier results from the union of seven glaciers from this mass; the larger branch descends from the snow-swathed, throne-shaped mountain, hitherto unmapped, for which the auriferous quartz found in its rocks suggested the name of The Golden Throne. This was fixed upon as the goal to be attained. The first attempt landed the Europeans and Ghoorkas, who made excellent climbers, on Crystal Peak, 20,000 feet in elevation, a peak as hard to climb as the Matterhorn, and isolated from the surrounding higher summits. No inconvenience was felt from the rarity of the air, and the party remained on the summit for an hour and a quarter. In the grand attempt on the Golden Throne serious difficulty was encountered from the terrible extremes of heat and cold. The last few thousand feet proved very exhausting; one of the Ghoorkas had to be left behind, suffering from mountain-sickness. Every step had to be cut in hard ice. Finally the summit was reached at an elevation of 23,000 feet; but the Golden Throne stood revealed much higher, and separated by a deep depression. From the summit of Pioneer Peak, probably the highest yet reached by man, a series of photographic views was obtained and prismatic compass bearings taken to the surrounding features. As long as the party were at rest they felt no discomfort, but the sphygmograph showed that the heart's action was very laboured. A stay of an hour and a quarter was made on the summit, the view from which baffled description. The descent was safely made, but fatigue and bad weather stopped further exploration.

THE INSTITUTION OF MECHANICAL ENGINEERS.

ON the evenings of Wednesday and Thursday of last week, the 26th and 27th ult., an ordinary general meeting of the Institution of Mechanical Engineers was held in the theatre of the Institution of Civil Engineers, by permission of the council of the latter Society. The President, Dr. William Anderson, occupied the chair during the proceedings.

There were two papers on the agenda. The first was the report of the Institution's committee appointed to enquire into the value of the steam jacket. Mr. Henry Davey is the chairman of this committee, and he had prepared the report; which is a bare record of facts without comment, and in this respect is, we think, defective. Numberless experiments have been made in time past as to the value of the steam jacket, and those now added by the labours of the committee do not largely differ from many that have gone before. We take it that the general opinion of competent engineers is that an advantage in efficiency is to be obtained by jacketing engine cylinders in an efficient manner, and cases in which the jacket has not been proved efficient are those in which it has not been properly applied. What was wanted, therefore, was guidance as to the proper method of application, and it is significant that the most help in this direction came, during the discussion, from those who were not members of the committee. Timidity in expressing opinion will be excusably construed as indicating something of incompetence, and if the members are not capable of expressing opinion they are not suitable persons to form a research committee of an important institution. We frame our remarks hypothetically, because, with such names as Unwin, Bryan Donkin, and Mair-Rumley on the title-page, there can be no doubt that the power to afford guidance was present, and for this reason the decision to give only bare fact is the more to be regretted. The general conclusion to be drawn from the experiments, as quoted, is that "the expenditure of a quantity of steam in an efficient jacket produces a saving of a greater quantity in the cylinder." It does not follow from this that the jacket is always desirable, as the saving may be so small as not to justify the additional complication and increased outlay at first cost. That, however, is a matter upon which steam users must themselves decide upon a commercial basis; and is, of course, outside the province of the committee, but what would have been valued would have been some critical remarks giving guidance as to what goes to constitute the "efficient jacket," what fresh engineering practice is opened up by the use of the efficient-jacket, and under what conditions it may be most effectually applied.

The first series of experiments quoted were carried out by Mr. J. G. Mair-Rumley, of the firm of James Simpson and Co., of Pimlico, upon a compound jet-condensing beam pumping-engine. The diameters of the cylinders are 29 inches and 47·5 inches, with strokes of 65·1 and 96 inches respectively. Only the body of each cylinder is jacketed, the steam being supplied direct from the boiler at a pressure of 49lbs. per square inch above atmosphere. Experiments were made both with and without steam in the jackets. The total feed water per indicated horse power per hour when the jackets were not in use was 18·20lbs., with the jackets in use the corresponding figures were 16·64 lbs., thus showing a percentage of less steam used due to the jackets of 8·6. The quantity of jacket water condensed was 1·20 lbs. per I.H.P. per hour. The boiler pressure here was not high, 49·7 lbs. without and 49 lbs. with jackets.

The number of revolutions were also low, 14·8 without jackets and 15·78 with jackets. This was evidently an engine which should pay for jacketing. We next come to an experiment of a different nature, carried out by Mr. Davey and Mr. W. B. Bryan. The engine is triple expansion surface-condensing engine of the inverted direct-acting marine type, and is placed in the Waltham Abbey pumping station of the East London Water Works. The cylinders were 18″, 30·5″, and 51″ in diameter, by 36 inches stroke. There is a Meyer expansion valve to the high pressure cylinder, by means of which the speed of the engine was regulated during the experiment. The bodies and both ends of all three cylinders are steam-jacketed. The jacket steam of the high pressure cylinder is at full boiler pressure, but the other two cylinders have the pressure reduced to a little above that of their steam-chests by means of reducing valves. Each cylinder is therefore jacketed with steam a little above its own initial pressure. Without the jackets in use the amount of feed water per I.H.P. per hour was 17·22 lbs, and with the jackets in use 15·45 lbs, showing a percentage of less steam used owing to the jacket of 10·3. The total jacket water was 1·72 lbs. per I.H.P. per hour. The coal consumption is given in these experiments, being 2·09 lbs. per I.H.P. per hour without the jackets, and 1·79 lbs. with. The amount of coal burnt is not, of course, necessarily a measure of economy of the engine, but possibly the steam-generating plant —which included an economizer—was practically constant in its duty during both trials, and if so the commercial gain by the use of the jacket is quite an appreciable quantity. The boiler pressure here was 130 lbs. above atmosphere, the number of expansions without the jacket 22, and with the jacket 30. The revolutions were 23 per minute, so that the jacket had again a favourable chance.

The next series of experiments were carried out by Colonel English, Mr. Davey, and Mr. Bryan Donkin, and in these we reach a much higher piston speed, so that the results stand on a somewhat different footing in this respect to those before quoted. We have no positive knowledge of this engine beyond that given in the report, but it would be desirable to know something more of its working before accepting the very high percentage of gain in steam used—19·0 per cent.—as that due to a steam jacket used on a good engine. The feed used per I.H.P. per hour was 24·68 lbs. without the jacket, and with the jacket in use the quantity was 20 lbs. The following are the particulars of this trial :—Horizontal surface condensing compound engine, with intermediate receiver cylinders, 18 and 32 ins. by 48 ins. stroke. The ends of the cylinders are not jacketed, and the receiver jacket was not in use during the experiment. The boiler pressure was 50 lbs., the revolutions 57·06 without jackets, and 63·62 with, the feed water supply as stated, and the jacket water condensed per I.H.P. per hour 1·13 lbs. The coal used without jackets was 3·26 lbs. per I.H.P. per hour, and with jackets 2·66 lbs.

The last set of experiments we shall quote were made by Prof. Unwin, upon the experimental engine[1] at the City and Guilds of London Central Institution, South Kensington. It is a two-cylinder horizontal-surface condensing engine, and can be worked either simple or compound. The cylinders are 8·73 inch and 15·76 in diameter, by 22″ stroke. The high pressure cylinder is fitted with Hartnell expansion gear, and the low pressure with Meyer expansion gear. Only the bodies and the back ends of the cylinders are covered. We will first give results of trials working the engine with the low pressure cylinder only. The pressure was 60 lbs. above atmosphere, the jacket pressure being taken direct from the boiler. The revolutions without the jacket were 112·40, and with the jacket 101·73. The feed water per I.H.P. per hour without the jacket was 32·14 lbs., and with the jacket 26·69 lbs. This gives a saving of 17 per cent. working simple. It will be seen presently that when the engine was working compound, the saving was 7·3 per cent. The jacket-water per I.H.P. per hour was 1·88 lbs. We will now take the records of the compound trial. The boiler pressure was 66·73 lbs. without the cylinders, and 67·80 lbs. with the jackets. The revolutions were 93·66 without the jacket, and 96·11 with. The feed water used per I.H.P. per hour was 21·06 lbs. without the jackets in use, and 19·52 lbs. with. The saving, as stated, made by the use of the jacket was therefore 7·3 per cent. The jacket water used per I.H.P. per hour was 2·40 lbs. We regret we are not able to give all the interesting details which Prof. Unwin includes in his instructive report, but for these we must refer our readers to the original paper.

[1] This engine is stated in the report to have been fully illustrated and described in *Engineering* of November 16, 1888. The triple expansion engine at Waltham Abbey is also said to have been illustrated and described in the issue of August 8, 1890, of the same publication.

Probably Prof. Unwin's 7·3 per cent. saving in steam used is a far better measure of the value of the jacket than the inflated promise of 19 per cent. in Major English's trial. It should be remembered that the jacket is more effective in small than in large engines, the area of cylinder will be in a higher ratio to the contained steam in the former than in the latter case. The number of expansions in the South Kensington engine working without jackets was 7·23, and with jackets 9·29. The corresponding figures in the case of the Woolwich engine were 9·4 and 12·6. The boiler pressure with the Woolwich engine was, however, 16 to 17 lbs. higher than in the other case. The revolutions were 57·06 and 63·62 respectively in the two trials at Woolwich, whilst at South Kensington they were 93·66 and 96·11. It would have been instructive if the committee had had the courage to attempt some balance of these figures, and then have endeavoured to account for the large difference which we believe would have remained still to be accounted for.

The next experiments quoted comprise a series made by Mr. Bryan Donkin, junr., at the works of his firm at Bermondsey. Mr. Donkin's labours in this field are well known, and engineering science is largely indebted to him for the contributions he has made to its lore. One most valuable feature in connection with these investigations is the means he has used to ascertain the temperature of the walls of the cylinder at various distances from the surface. In this lies the essence of the problem. If the Jackets Committee would give us minute and trustworthy information on this point we could evolve the rest from existing data. If we do not quote Donkin's figures in full it is partly because his experiments are not yet complete and partly because they have been dealt with more fully in "another place," namely, the Proceedings of a Society other than tha with which we are now dealing.[1] We may state, however, that in one case when the steam in the jacket space was 298° Fahr. the cylinder walls averaged 290° Fahr., whilst at 0·06 in. from the piston the temperature of the cylinder wall was 284° Fahr. These temperatures were ascertained by thermometers placed in holes drilled in the cylinder. Other instances are given, but the matter is far too interesting to deal with in a cursory manner, such as a report of this nature alone warrants. The difficulty that suggests itself is the fact that a thermometer itself has a very appreciable thickness, and the record will be but a mean of the temperature due to that thickness. It is possible that Mr. Donkin gets over this difficulty in some way. Perhaps the thermo-couple as used by Le Chatelier might afford a solution, although this apparatus is not so useful for recording small differences at low temperatures, being rather adapted for such work as hot blast stoves and other metallurgical purposes. Mr. Bryan Donkin's experiments are the most suggestive in the report, as might be anticipated. Trials were made with steam at various rates of expansion to determine the effects of the steam-jacket on the speed of engine and temperature of the cylinder walls, and on superheating. The engine used was a small one (6″ × 8″), but it was specially constructed and arranged for the work. We again repeat Mr. Donkin's investigations are well worthy of the study of all interested in these matters.

The report concludes with a valuable appendix in the shape of suggestions for the use of those desirous of experimenting in this field.

The discussion on this paper was of a protracted nature, but was not of a kind altogether worthy of the leading mechanical institution of the country. Mr. Morrison, of Hartlepool, made the most weighty contribution amongst the speakers. He pointed out the difficulty of maintaining a good circulation of steam in the jacket—one of the most important points to which the designer of jacketed engines should turn his attention—and illustrated a simple method by which he had secured this end. His arrangement consisted of a series of diaphragms, by means of which the steam was made to take a devious course through the jacket. Mr. Schonheyder pointed out a mistake the committee had made in placing an air-cock on the top of the jacket, when it was required to draw off air from the steam. Of course, this is one of those little slips which the wisest are apt to make, for it would be absurd to suppose such authorities as those en-

[1] See Proceedings Inst. Civil Engineers.

gaged did not know that air is heavier than steam. One might as well say one's grocer did not know sand from sugar.

The Jackets Committee has not yet concluded its labours, and another report will be forthcoming in due course. Mr. Aspinall has offered a locomotive for trial, and we heard that Mr. Yarrow will put a torpedo boat at the disposal of the committee, and has even promised to cast special cylinders for experimental purposes. The locomotive will afford an interesting field of research, running as it does so largely linked up. The torpedo boat experiments will be no less interesting, especially in view of the great number of revolutions the engines of these craft make in a given time.

On the second day of the meeting the paper by Mr. Walker of Bristol on the screw propeller. This paper gives the details of some experiments made by the author on a form of screw propeller invented by the late Mr. B. Dickinson. It would be in vain for us to attempt to condense this paper within the limits at our disposal. With regard to the merits of the Dickinson propeller we have nothing to say. It consists essentially of two narrow blades in place of one, and reminds us strongly of a Mangin propeller with one blade set somewhat back on the shaft. Mr. Walker contends that his researches prove the advantages of long narrow blades, but he did not appear to have converted the high authorities present, including Mr. Froude, Mr. Thorneycroft, and Mr. Barnaby—the three best-known names in connection with the subject—to his views. It is difficult to see wherein the value of the paper exists. Prof. Kennedy in the discussion stated that the generally received opinion as to the increase of the friction of the load was erroneous, and that the power absorbed in this way does not increase in the manner stated, a fact which he illustrated by means of a diagram. Mr. Thorneycroft pointed out that "life was not long enough" for the larger trials proposed by the author, but that he might decide one point if he would confine himself to models. Mr. Barnaby stated that a broad-bladed propeller should not be a uniform pitch. Mr. Froude's speech was a lucid criticism of the author's paper, the speaker pointing out in a kindly but convincing manner that the conclusions arrived at by the author might be subject to revision. Mr. Dunell, whose previous experiments the author had quoted, added to the information given by putting forward some other experiments he had made upon screw propellers fitted to a torpedo boat, in this case the results being opposed to those claimed by the author, inasmuch as the shorter and broader blade had proved the more advantageous. Mr. Shield, of Liverpool, described a form of propeller which has been in use on the Mersey, and appears to offer some advantages. The blades are attached to the boss in two parts, and are joined in a loop at the top. According to Mr. Shield's statement, the arrangement gives great advantages in towing, and also increased steadiness in running. The latter we can accept as a fact, but the great increase in towing capacity seems almost too good to be accepted literally. Twenty-five per cent. additional efficiency is a very large gain without further expenditure than an exchange of screws; but this is what the propeller in question is said to realize.

The meeting concluded with the usual votes of thanks.

INTERNATIONAL COMMITTEE OF WEIGHTS AND MEASURES.

THE International Committee of Weights and Measures, which was established in consequence of the Metric Convention of 1873, has recently issued its fifteenth annual report to the Governments represented at that Convention.[1] The committee have also lately published the minutes of their proceedings (Procès-Verbaux des Séances. Paris, 1892. 1 vol. 8vo) at the annual meeting held at Paris in September, 1891. It appears to be hardly possible that the proceedings of the committee at their meeting which was held last month may be issued before next year, but from the above publications, as well as from a recent volume of their "Travaux et Mémoires," we gather that they continue to carry on their investigations with all despatch.

In their last report the committee deplore the death of their colleague, Jean-Servais Stas, whose analyses of the platinum alloys have, together with those of St. Claire Deville and George Matthey, so largely helped forward the principal work of the committee; the metallurgical studies of Stas are indeed recognized as veritable models of classical research in this particular field.

The new instruments added to the Bureau at Sèvres during the last year include a normal barometer (le Baromètre Fuess) and manometer, originally verified for reference as an international standard in accordance with the decisions of the Meteorological Conferences, particularly that at Munich last year. The committee have also obtained a new apparatus for determining the normal thermometric "boiling point," or the temperature of 100° Centigrade, as it has been found that the form of apparatus used by Regnault was unreliable for this purpose. In the reading of the standard manometer it would appear that higher accuracy has been obtained by raising the surface of the mercury up to a fixed point, the image of the point in the mercury being observed at the same time by means of a microscope. The Wild-Pernet barometer has been remounted, and the Bureau are now prepared to undertake the verification of any standard barometer.

The readings of all mercurial thermometers are given at the Bureau in terms of the hydrogen thermometer; and a 30-litre holder for methyl chloride, or liquid carbonic acid, has been made by Brigonnet and Navile. The low temperature experiments have been continued by M. Chappuis down to −75° Cent.; and toluol and alcohol thermometers have been compared with the hydrogen thermometer. It has been found that "toluol" is more sensitive and reliable for low temperatures than alcohol.

We note that the meteorological work of the committee has largely developed itself; and that, as in geodetic research, the Bureau at Sèvres is now recognized as a central and international station of reference. Standard thermometers have been verified, for instance during 1892, for the Governments of Russia, France, and Roumania; for the Universities of Rome, St. Petersburg, and Odessa; for Owens College, Manchester; and for several recognized meteorological observatories. Great Britain has also been supplied by the committee with standard thermometers similar to those supplied to other contracting States.

Besides the standard metre and kilogramme already delivered to this country, the Bureau is undertaking the construction of a further standard metre for the Board of Trade, at a cost of 12,588 francs. The new standard appears to have been nearly two years in construction, but its verification is now promised this year.

There are twenty-one different governments who have joined the Convention and who contribute annually towards the expenses of the Bureau (the annual budget of which is 75,000 francs), sums varying from 134 francs (Denmark) to 9482 francs (Germany) the annual contribution of Great Britain and Ireland for 1892 being stated at 4699 francs, or nearly £188; and that of the United States at 8471 francs.

At the instance of Dr. B. A. Gould the committee are now also undertaking an inquiry affecting measurement by light waves. By the use of the "Refractometer" Dr. Michelson found (*Philosophical Magazine*, April, 1891, and September, 1892) that accuracy of measurement by light-waves may be increased to a high degree of accuracy. By the best spectroscopic instruments now in use it has been stated to be difficult to "resolve" lines as close together as the components of the yellow sodium lines, but that if the width of the lines themselves be less than their distances apart, then there is no limit to their accuracy of measurement by the "Refractometer." We shall look forward with interest to the publication of Dr. Michelson's further results, in the next volume of the "Travaux et Mémoires" of this committee.

The new instrument designed by M. Gustave Tresca, of the Conservatoire des Arts et Metiers at Paris, for the adjustment and polishing of the terminal surfaces of end-measures of length appears also to be better than anything yet adopted in England.

The committee not only undertakes the verification of standards and instruments for the High Contracting Governments (who have the right to demand such verifications), but they also verify for any scientific authorities or persons. To those of our readers, therefore, who may desire to have standards or instruments verified by the committee, the following information may be useful:—

Applications for the verification of instruments should first be made to M. le Directeur du Bureau International (Dr. René Benoît), au Pavillon de Breteuil, Sèvres, près de Paris.

[1] Rapport du Comité International. Gauthier-Villars. Paris. 1 Vol. 50 pp., 1892.

Standards may be sent to Sèvres by post or railway (at the cost and risk of the owner); or still better, they may be delivered and removed from the Bureau by the owner or his agent. A certificate of verification will be given when the standards are ready for removal. In any application to the director the denomination of the standard, or the description of the instrument, should be stated, and the nature and extent of the verification demanded.

The committee will verify metric standards of length of one, two, three, and four metres, or subdivisions of the standard metre, if made in metal or some durable stone. Line-measures should have their graduations so fine as to be well observed with a microscopic power of sixty diameters; and end-measures should have their terminal surfaces sufficiently adjusted and polished so as accurately to define the length of the bar. Measures of mass may be made also of metal or some durable stone, but each must be in one piece without handles, grooves, or adjusting holes. For thermometers and barometers special regulations are issued, which may be obtained at a small charge from MM. Gauthier-Villars, 55, Quai des Grand Augustins, Paris.

The fees on verification of measures of length vary from 60 to 400 francs, according, of course, to the extent of the verification demanded; for metric weights from 20 to 120 francs; and for thermometers and barometers from 10 to 80 francs.

What should be the true equivalent length of the yard measure in terms of the metre, may appear to some to be almost a trifling matter—because the measurement in dispute, or probable error of the equivalent at present adopted in this country, amounts only to 0·0008 inch. It is, however, a fact that so small a difference as 0·0008 in this equivalent would not only be felt in scientific researches but also in practical work. Messrs. Comstock and Tittman, of the United Coast Survey, as well as Dr. Peters, of Germany, and the Director of the International Committee, have found that the equivalent length of the metre (39·3708 inches) as ascertained by Kater and Arago, in 1818, is inaccurate, to the extent of 0·0008 inch, and that the true equivalent ought to be nearly 39·3700 inches. This latter value will, we have no doubt, be ultimately recognized in scientific work.

In the field of electrical measurements, we find that Dr. Guillaume is continuing his investigations as to the measurement of temperature by electrical methods; and as to the variations of mercurial standards of resistance, a work originally begun at the Bureau, by Dr. Benoît, in connection with the standard ohm. It would not appear that mercurial thermometers can be superseded for ordinary measurements of temperature, but that measurement by resistances may afford useful results in determining the temperature of a given mass or space, as the whole length of a column of mercury. Dr. Guillaume gives an account of his work on mercurial standards in the Procès-Verbaux recently issued (page 183).

During the past year Commandant Defforges, of the Geographical service of the French army, has been undertaking at the Bureau an inquiry into the effect of the force of gravity at the latitude of Breteuil, by means of a seconds pendulum and apparatus constructed by Brunner. M. Defforges found that at Breteuil (longitude east of Paris 0°·131, latitude north 54·260, and altitude 70·4 metres) $G = 9{\cdot}80991$ m.

We cannot conclude this glance at the recent work of the International Committee without expressing an opinion that the scientific success of their work and the accuracy of its record, owe much to the energy and watchful care of the new president, Dr. Foerster, and the secretary of the committee, Dr. A. Hirsch.

NOTES ON SOME ANCIENT DYES.[1]

THE fragments of ancient dyed fabrics which I have examined I owe to the kindness of Mr. R. D. Darbishire. They are specimens from a lot found by Mr. Flinders Petrie in a tomb at Garob, Lower Egypt, supposed to date from 400–500 A.D. They were used apparently for filling the mummy cases where required, not strictly speaking as grave clothes. My object in examining them was to ascertain, if possible, what were the materials employed in producing the various colours seen on them. The fabrics examined consisted almost entirely of wool. Here and there in the warp of some of the specimens were threads, conspicuous for difference in colour, consisting of linen. The following colours could be distinguished:—blue, yellow, green, red, maroon, purple or claret, black. I will take them in the order named.

Blue.—The colour of the fabric was a dull medium blue. On treatment with hot caustic lye a great part of the wool dissolved. The residue, which was dark blue, having been filtered off, washed and dried, was treated with boiling aniline, to which it communicated a bright blue colour. The blue solution having been filtered boiling, deposited on cooling a quantity of blue crystalline scales, which, after being filtered off, washed with alcohol and dried, were found to consist of indigo blue. On being treated in a tube they gave a sublimate of regular crystals, blue by transmitted, copper-coloured by reflected, light; they dissolved in concentrated sulphuric acid, giving a blue solution, and the solution in aniline showed the absorption spectrum of indigo blue. It is evident, therefore, that indigo in some form or other was the material used in dyeing this colour.

Yellow.—The colour of the patches dyed yellow was so evidently faded, and showed so little intensity, as to make it very uncertain whether analysis would lead to any precise result; the examination was therefore omitted.

Green.—Of the material dyed this colour, I had but a small quantity, but it was sufficient to allow of some conclusion regarding the means whereby the colour was produced. On being treated for some days with dilute hydrochloric acid it imparted to the latter a deep yellow colour. The portion left by the acid, after being washed and dried, yielded indigo blue on treatment with boiling aniline. It is probable, therefore, that the colour was produced by first dyeing the fabric with indigo, then treating with some mordant, such as alum, and, lastly, dyeing with some yellow colouring matter, most likely of vegetable origin. With the small quantity of material at my disposal, I found it impossible to ascertain the nature of the yellow colouring matter employed.

Red.—This was the most pronounced, and at the same time the most interesting, of the colours examined. The colour of the fabric was a full deep red. It might be called a Turkey red; the dye, in fact, proved on examination to be a kind of Turkey red as having the characteristic properties of that dye.

On being burnt, the fabric left a considerable quantity of ash, consisting of calcium sulphate, alumina, aluminium phosphate, ferric oxide, and silica. A large portion of this ash no doubt represents the mordant employed in producing the colour. On treatment with hot dilute hydrochloric acid, the fabric lost its red colour and became yellow. After removal of the acid by washing with water, and pressing between blotting paper, treatment with boiling alcohol deprived the wool of the greater part of the yellow colour, a faint tinge only being left. The deep yellow alcoholic liquid obtained left on evaporation a reddish-brown amorphous residue. This, on being treated with a boiling solution of alum, dissolved in part, yielding a pink fluorescent liquid, which had exactly the same colour, and showed precisely the same absorption bands as a solution of purpurin from madder in alum liquor. On adding hydrochloric acid to the pink solution and heating, the colouring matter was precipitated in orange-coloured flocks, the liquid becoming almost colourless. The flocks after being filtered off and washed with water dissolved easily in boiling alcohol, yielding a yellow solution, which, on spontaneous evaporation, left a quantity of dark yellow needles arranged in rosettes. These needles dissolved in caustic alkali, giving a cherry-red solution, which showed the absorption bands of purpurin. The solution, on exposure to air and light, became colourless.

Some of the precipitated colouring matter, on being employed in the usual way for dyeing a bit of calico to which various mordants had been applied, yielded colours exactly like those obtained with purpurin from madder, *i.e.*, the alumina mordant gave a bright red, the iron mordant dull purple to black tints. The matter left undissolved, after repeated treatment with boiling alum liquor, was still highly coloured. It dissolved easily in alcohol, the solution leaving on evaporation a brown amorphous residue, which remained soft even after long standing. This residue consisted for the most part of fatty matter, but it also contained some colouring matter insoluble in alum liquor. That this colouring matter was alizarin seemed probable, since the colour which the mixture imparted to alka-

[1] Reprinted from "Memoirs and Proceedings of the Manchester Literary and Philosophical Society," 1891-92 (Fourth Series, vol. 5, No. 2).

line lye resembled that of an alkaline solution of impure alizarin.

These experiments lead to the conclusion that the red colour of the fabric was produced by dyeing with some kind of madder, either wild or cultivated, the fabric having been previously treated with a mixed aluminous and ferric mordant, and then probably oiled—that it was, in fact really a kind of Turkey red.

Maroon.—The dull chestnut colour of this fabric presented a striking contrast to the bright red of the preceding. Its constitution was, however, similar. Having treated it in the same way as the other, I found that the colouring matter must have been derived from madder; fatty matter was also present, but the mordant contained a larger proportion of ferric oxide, a fact which sufficiently explains the brown tint of the dyed fabric.

Purple.—The fabric in which this colour was seen was made up of a pale yellow warp, and a weft of a dull purple or claret colour. The latter colour was found to be due to an intimate mixture of red and blue, for the threads, on examination under the microscope, were seen to consist partly of red, partly of blue fibres, the former predominating. The two sets of fibres had, of course, been mixed before spinning. The blue fibres were certainly dyed with indigo, the red probably with madder.

Black.—The colour of the black fabric, like that of the green, was a compound of two colours, one overlying the other. Under the microscope the individual threads appeared grey. On treatment with a mixture of alcohol and hydrochloric acid they changed colour, a yellow liquid being obtained, while the fabric itself now appeared blue, and after washing and drying yielded indigo by appropriate treatment. The yellow alcoholic liquid was found to contain purpurin. The colour may be supposed to have been produced in the following manner:—The woollen fabric having first been dyed blue was mordanted, to use a modern phrase, and then dyed with madder, the two colours together producing the effect of black.

EDWARD SCHUNCK.

SCIENTIFIC SERIALS.

IN the *Botanical Gazette* for July, August, and September, there are several papers of general interest. Mr. G. A. Rex presents a further contribution to our knowledge of the Myxomycetes in an account of the genus *Linbladia.*—Mr. D. T. McDougal gives a detailed account of the morphology and anatomy of the tendrils of *Passiflora cærulea.*—Mr. M. B. Thomas describes and figures an apparatus for determining the periodicity of root-pressure in plants.—Mr. C. L. Holtzman has a short paper on the Apical growth of the stem and the development of the sporange in *Botrychium virginianum*, his observations favouring the view that the Ophioglossaceæ are a more primitive form than the typical Filices.—Mr. A. F. Foerste continues his observations on the Relation of autumn to spring-blossoming plants.—Mr. Charles Robertson gives a further instalment of his series of papers on Flowers and insects.—A brief report is given of the botanical papers read at the recent meeting of the American Association for the Advancement of Science.

IN the *Journal of Botany* for September and October, no less than four new species are added to the British flora and to science—*Hieracium hibernicum*, *H. duriceps*, and *H. Breadalbanense*, by Mr. F. J. Hanbury; and *Ranunculus petiolaris* (sect. Flammula) by Rev. E. S. Marshall.—Rev. W. Moyle Rogers continues his Essay at a key to British Rubi; Mr. E. G. Baker his Synopsis of genera and species of Malveæ; and Mr. W. A. Clarke his First Records of British Flowering Plants.

Bulletin of the New York Mathematical Society. Vol. ii. No. 1, October, 1892. (New York.)—Prof. Cajori opens this number with an interesting note on the evolution of criteria of convergence (pp. 1–10), in which he discusses some special and general criteria furnished in the writings of Gauss, Cauchy, Abel, DeMorgan, Bertrand, Kummer, and others, and notices specially the remarkable advance made by Pringsheim (*Math. Ann.* vol. xxxv.).—Dr. A. Martin calls attention (pp. 10–11) to a slip in Ball's "Short History of Mathematics" (p. 102), the probable origin of which is accounted for by Mr. Ball.—There is a slight review of Chapman's "Elementary Course in the Theory of Equations" (pp. 11–12), and the rest of the issue is taken up with the usual list of new publications and notes. In these last Dr. Martin points out a curious error in the Royal Society "Catalogue of Scientific Papers," vol. ix. (1874–1883), where, of the papers accredited, on p. 790, to Ezekiel Brown Elliott, Nos. 5–11, 14–17 should be assigned to Mr. Edwin Bailey Elliott, of Oxford, and not to the late Mr. Ezekiel Brown Elliott, of America, to whom Nos. 4, 12, 13 are rightly attributed.

IN the *Bullettino* of the Botanical Society of Italy, we find in addition to papers of more local interest, a further communication from Sig. Macchiati on the Cultivation of diatoms, in which he states that the presence of infusoria and of diatoms in the water is mutually beneficial to one another, while the most destructive enemies of the latter are bacteria.—A paper by Sig. Piccioli on the Biological relations between plants and snails, is chiefly devoted to the protective contrivances found in the former against the attacks of the latter, the most important of which are of a chemical nature—tannin, latex, oleiferous glands, and poisonous salts such as calcium oxalate: mechanical means of protection, such as hairs and a comparatively thick cuticle, play a subordinate part.—In a further communication by Prof. Arcangeli on the Cultivation of *Cynomorium coccineum*, he states that he does not find such an intimate parasitism with its host as is the case with the Rafflesiaceæ and the Balanophoraceæ.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 24.—M. de Lacaze-Duthiers in the chair.—Researches on the fixation of atmospheric nitrogen by microbes, by M. Berthelot. The investigation was made in order to elucidate the mechanism of the fixation of atmospheric nitrogen. It appears that the presence of green vegetable material is not essential to the process. The colourless bacteria are able to absorb nitrogen when supplied with humic acid only as nutriment. The assimilation takes place more readily with natural than with artificial humic acid, probably because the former contains more nitrogen. In experiments with hermetically sealed cultivations it was found that the gain of nitrogen by the organic material under cultivation was 6 or 9 per cent. in excess of that supplied by the humic acid, the difference being derived from the enclosed air. With an occasional stream of dust-laden air this was brought up to 30 per cent.—Coloured photographs of the spectrum on albumen and bichromated gelatine, by M. G. Lippmann. Albumenized and gelatinized plates soaked in bichromate of potash may be employed for photographing in colours. They are used like silver-salt plates, being placed so that the mercury is in contact with the film. The colours will appear immediately after immersion in water, which develops and also fixes the image. It disappears on drying, but reappears as soon as the plate is soaked. The colours are very brilliant, and visible at all angles. Those of gelatine plates are brought out by simple breathing. The theory is analogous to that of silver plates, the maxima and minima of interference producing hygroscopic and non-hygroscopic layers with varying refractive indices.—The irrigation canals of the Rhone, by M. Chambrelent.—A new apparatus, the schiseophone, serving the purpose of exploring the internal structure of metallic masses by means of an electro-mechanical process, by M. de Place. The apparatus consists of a microphone and an induction sonometer. To the microphone is attached a rod of hard steel, kept oscillating once or twice per second, and striking each time against the casting or other mass of metal under investigation. The sonometer, consisting of two coils movable towards or away from each other along a divided scale, with a telephone connected with one of the coils, is placed in another room, and joined by wires to the microphone. The coils being so adjusted that the tapping is scarcely perceptible at the sonometer, the casting is moved so as to expose various portions to the impacts. If the thickness be uniform, any flaw or fissure will be at once indicated by a change in the sound.—Observations of the comet Barnard (D 1892), made at the Paris Observatory, by M. G. Bigourdan.

—Elements of the comet Barnard, of October 12, 1892, by M. L. Schulhof.—On the algebraic integrals of the differential equation of the first order, by M. L. Autonne.—On centres of geodesic curvature, by M. Th. Caronnet.—On Pfaff's problem, by M. A. J. Stodolkievitz.—Sunspots and magnetic disturbances in 1892, by M. Ricco.—On considerations of homogeneity in physics; reply to M. Clavenad, by M. Vaschy.—Verification of parallelism of optic axes in uniaxial crystalline plates, by M. Bernard Brunhes.—On a photoptometric photometer, for the measurement of feeble illuminations, by M. Charles Henry. This is based upon the constancy of the phosphorescent sulphide of zinc. Its law of loss of brilliance being determined, it may be used for measuring very feeble illuminations, such as distant artificial light or the general luminosity of the sky due to the stars. The decrease of light after the first 900 seconds being given by $i^{0 \cdot 5}(t - 18 \cdot 5) =$ const., it is easy to calculate the luminosity at any instant. In the instrument in question there are two screens of ground glass, one of which is illuminated by the phosphorescent sulphide, brought to its maximum glow at a certain time by burning magnesium ribbon, the other exposed to the source of light. It is then only necessary to wait till both the screens are equally illuminated, and to note the time.—On the dissociation of chrome alum, by MM. H. Baubigny and E. Pechard.—On the temperatures of maximum density of aqueous solutions, by M. L. de Coppet.—On some double salts of quinine, by M. E. Grimaux.—On the thermal value of the three functions of orthophosphoric acid, and on its constitution, by M. de Forcrand.—Preparation and properties of fibroine, by M. Leo Vignon.—Regeneration of the so-called sporangial form in the diatoms, by M. P. Miquel.—On the hematozoaria of cold-blooded vertebrates, by M. Alphonse Labbé.—Influence of coloured light on the development of animals, by M. E. Yung.—On the mode of fixation of the hexapod parasitic larvæ of the acarians, by M. S. Jourdain.—The cavern of Brassempouy, by M. Edouard Piette.—Discovery of a skeleton of *Elephas meridionalis* in the basaltic ashes of the volcano of Senèze, by M. Marcellin Boule.—Vegetable prints of the Dover boring, by M. R. Zeiller.

Berlin.

Meteorological Society, October 11.—Prof. von Bezold, president, in the chair.—Dr. Berson reported on an interesting relationship which he had discovered between insolation and temperature. Since it has not yet been possible to determine accurately the absorption due to the atmosphere, the speaker had calculated the insolation at the external limit of the atmosphere, which admits of rigid mathematical treatment, both for the whole year and for the months of January and July. The mean of insolation for the whole year was found to lie at the thirtieth degrees of northerly and southerly latitude, so that the zone between these parallels, or about 60 per cent. of the whole external surface, receives more insolation than the mean, whereas the two polar caps, or the remaining 40 per cent., receive less. A similar calculation of the annual temperature gave the mean as at latitude 38° N. and 35° S., giving as before 60 per cent. of the surface with the temperature above the mean, and 40 per cent. below. In January 61·35 per cent. of the surface experienced an insolation above the mean and 60 per cent. a temperature above the mean, while in July the percentages were respectively 61·37 and 61·33.—Dr. Zenker gave a short account of a research on the relationship between temperature and insolation on the earth's surface. He had accurately calculated the relationship both for regions comprising land only and water only, and arrived at some interesting conclusions as to the theoretical temperatures at various latitudes of continents and oceans.

Physical Society, October 21.—Prof. Kundt, president, in the chair.—Dr. Jäger gave an account of the measurements he had made, in conjunction with Dr. Kreischgauer, of the temperature-coefficient of electric conductivity of mercury. Dr. Arons demonstrated an arc-light between mercurial electrodes in vacuo. It yielded a dazzling white light, which was steady at the anode but flickered and jumped at the cathode: its intensity approximated to that of an ordinary carbon arc-light. The heat given off by it was but slight so that the tube could be held in the hand; the temperature was highest at the cathode. Attempts were made to determine the resistance of the arc, but without result. It was found by the use of a telephone that the current is discontinuous. A spectroscopic investigation of the light revealed a lime-spectrum showing very brilliantly a yellow, a green, and a blue line. In addition to the ordinary lines due to mercury some twenty new lines were observed. No satisfactory results were obtained by using amalgams instead of mercury, with the one exception of sodium-amalgam. It is proposed to make further experiments with fluid amalgams of sodium and potassium.

BOOKS and SERIALS RECEIVED.

Books.—The Great World's Farm: S. Gaye (Seeley).—The Zoological Record, 1891 (Gurney and Jackson).—Castorologia, or the History and Traditions of the Canadian Beaver: H. T. Martin (Stanford).—Transactions of the Royal Society of Edinburgh, vol. xxxvi. Parts 2 and 3 (Edinburgh).—Les Alpes Françaises: A. Falsan (Paris, Baillière).—Calendar of the University College of Wales, Aberystwith, 1892-93 (Manchester, Cornish).—London Birds and other Sketches, revised edition: T. D. Pigott (Porter).—Contents and Index of the First Twenty Volumes of the Memoirs of the Geological Survey of India, 1859-83: W. Theobald (Calcutta).—Memoirs of the Geological Survey of India; Index to the Genera and Species described in the Palæontologia Indica, up to the Year 1891: W. Theobald (Calcutta).—Star Atlas: Dr. H. J. Klein, translated, &c., by E. McClure, new edition (S.P.C.K.).—City and Guilds of London Institute Programme of Technological Examinations, 1892-93 (London).—Appareils d'Essai à froid et à chaud des Moteurs à Vapeur: M. Dudebout (Paris, Gauthier-Villars).—Canon Torpilles et Cuirasse: A. Croneau (Paris, Gauthier-Villars).—Ostwald's Klassiker der Exakten Wissenschaften, Nos. 31-37 (Leipzig, Engelmann).—Gesammelte Abhandlungen über Pflanzen-Physiologie, Erster Band: J. Sachs (Leipzig, Engelmann).—On the American Iron Trade and its Progress during Sixteen Years: Sir L. Bell (Ballantyne).—Universal Atlas, Part 20 (Cassell).

Serials.—The Physical Society of London, Proceedings, vol. xi. Part 4 (Taylor and Francis).—Botanical Gazette, October (Bloomington, Indiana).—Traité Encyclopédique de Photographie, Premier Supplément A. quat. fasc.: C. Fabre (Paris, Gauthier-Villars).—Zeitschrift für Wissenschaftliche Zoologie, liv. Band, 4 Heft (Williams and Norgate).—Morphologisches Jahrbuch, xix. Band, 1 Heft (Williams and Norgate).

CONTENTS.

THURSDAY, NOVEMBER 10, 1892.

EXPERIMENTAL BIOLOGY.

Experimental Evolution. By Henry de Varigny, D.Sc. (London: Macmillan, 1892.)

DR. HENRY DE VARIGNY has enriched the literature of biology by publishing in the "Nature Series" the lectures on "Experimental Evolution" delivered by him in 1891 to the Summer School of Art and Science in Edinburgh. This school, as is well known, has been doing good work on Extension lines in Edinburgh, and Prof. Geddes is to be congratulated on having secured the co-operation of so able a biologist and so lucid an exponent of the special aspects of biology with which he has identified himself as M. de Varigny. The lectures are well worthy of publication, for they contain a rich, well-ordered, and, for the most part, well-sifted body of facts collected from many sources, and especially from the publications of French naturalists. But the author is more than a collector of facts recorded by other workers; he is himself a worker in this special field of biological science. And some of the most valuable of the observations contained in the work are the result of his own careful and exact investigations.

Experimental biology is still in its infancy. It is true that our domesticated animals and plants are the result of much experimental work in the past; but the experiments were not planned with the object of explaining organic nature, and were therefore not biological in their aim. There is pressing need at the present time for experiments with such definite scientific aim; for experiments, that is to say, carried out with the express object of testing the truth of biological principles. And that this work be well done there is pressing need for organization. We have only to look at the results which have been reached by well-planned and well-directed marine stations in extending our biological knowledge, faunal, morphological, and embryological, to see what may be done by organization of research. What Dr. de Varigny eloquently pleads for, and what our own countryman, Dr. Romanes, is also pleading for, is an experimental institute, well planned and adequately supported, the purpose of which shall be to carry out extensive experiments for testing evolution hypotheses in all their bearings.

"It appears to me," says Dr. de Varigny, "that this institution should comprise the following essential elements:—Rather extensive grounds, a farm with men experienced in breeding, agriculture, and horticulture; some greenhouses, and a laboratory with the common appliances of chemistry, physiology, and histology. Of course this must be located in the country. It is very important to have experienced farm hands, and a good chemist and histologist are necessary in the staff of the institution. As to the general management, it seems advisable to have a director with a board of competent men, whose functions would be to decide, after careful investigation and exchange of views, what are the fundamental experiments to be performed. These experiments, when once decided upon, should be pursued during a long period of years, and nothing should be altered in their execution unless considered advisable by the board, or unless the experiment should be found useless, or devoid of chance of success. The main thing should be to provide for the duration of the experiment, whether the originators were living or dead, and to follow it out for a long time. Time is an indispensable element in such investigations, and experiments of this sort will surely exceed the normal duration of human lifetime."

A special branch of the work of such an institute should be experimental investigations in comparative psychology. Of this there is nowadays some need. Speaking of the transmission of acquired characters, Dr. de Varigny says, "Psychology affords similar instances. A kitten which has never seen a dog is afraid from the first moment it perceives one; young birds of many species instinctively fear the hawk and other birds of prey, while remaining unaffected by the presence of other birds. Are not these psychological 'attitudes' due to environment (acting on the *mens* of ancestors) which have been transmitted by inheritance; are these not *acquired characters?*" From observations of my own I am prepared to say that it is by no means universally true that a kitten which has never seen a dog is afraid from the first moment it perceives one. Mr. Spalding does indeed describe how the smell of his hand with which he had been fondling a dog set four blind kittens puffing and spitting in a most comical fashion. But a careful observer, Mr. Mann Jones, writes to me that a young kitten with which he experimented "took eight days to connect the smell or odour of his hand with the thing—dog." And my own observations are confirmatory of those of Mr. Mann Jones. Mr. Hudson, in a very interesting chapter of the "Naturalist in La Plata," gives observations which tend to show that young birds afford little evidence of instinctive fear of particular enemies; and my own experiments with young chicks lead me to believe that they have no instinctive knowledge of the things of this world. Any unusual and sharp sound (*e.g.*, a chord on the violin), any large approaching object (*e.g.*, a ball rolled towards them), causes alarm. There is no evidence of instinctive particularization of alarming objects. Such observations lead me to look with suspicion on any arguments for the transmission of acquired characters based on supposed instinctive knowledge of things. And they show the need of further research in comparative psychology such as could be carried out at the Institute of Experimental Biology.

It may be said that the central hypothesis of modern evolution, that of natural selection, stands in no need of experimental verification. But it will presumably be admitted, even by those who are firm in their belief, among whom I count myself, that further experimental support will be of the utmost value. There are many who assume a sceptical attitude, and who say—We grant the inexorable logic of your conclusions if your premisses be established. More individuals are born than can or do survive; the devil devours the hindmost; and a beneficent selection rewards the survivors with the privilege of procreation: hence, progress towards increased adaptation. A very pretty piece of logic. But now, they say, show us the devil at work. We pretend to no particular knowledge

of these matters, but we are quite ready to be convinced by proven facts. Prove to us this devil's work, and we acquiesce in your conclusion. But do not put us off with a logical "must be," the recognized symbol of an assumption. Do not tell us that since a hundred were born and only two survive, the ninety-eight must be in some way and for some reason unfit. This is just the very fact of which we require definite and indubitable evidence.

Now what solid and umimpeachable body of evidence have we wherewith to conclusively refute this scepticism? If animals or plants removed to a new environment assume a new habit, in how many cases is it clearly *proved* that this is due to the elimination of all those who failed to vary in the direction of this habit? It behoves us to be careful that the very strength of the natural selection hypothesis be not a source of weakness, by leading us to neglect the duty of experimental verification. That there should be a central institute or institutes for the purpose of such experimental verification, is what Dr. de Varigny and Dr. Romanes are pleading for. It would produce a salutary organization of research; for the institute would have carefully selected correspondents in all parts of the world who would carry out their experiments in concert. It would bring scattered energies to a focus. It would by its journal show individual workers where research is specially needed. It is bound to come sooner or later. We hope to see it an established fact before the close of the present century.

C. Ll. M.

BRITISH FUNGUS FLORA.

British Fungus-Flora, a Classified Text-Book of Mycology. By George Massee. In 3 vols. Vol. I. (London and New York: George Bell and Sons, 1892.)

IT was in 1836 that Berkeley published his "British Fungi" as a part of Hooker's "British Flora," and for about a quarter of a century this was the standard work. In 1860 appeared Berkeley's "Outlines of British Fungology," which from the first was disappointing, inasmuch as it was only a barren catalogue for all except the large and conspicuous species; and even the latter were so compressed in description, by the exigencies of confining the book within narrow and definite limits, that it did not wholly supersede the use of the old "British Fungi." In 1871 an effort was made to repair the error by the publication of Cooke's "Handbook of British Fungi," which brought the whole subject up to date, and gave a new impetus to British mycology. On account of the considerable acquisition of species, new to the British flora, it was deemed fitting in 1871 to produce a new work which should include these additions, and then Stevenson's "British Fungi" appeared. This new work only included the "Hymenomycetes," or, in effect, part of the first volume of Cooke's "Handbook," leaving all the rest untouched. In order to remedy this deficiency in part, Cooke's "Myxomycetes" was issued in 1877, and Phillips' "Manual of British Discomycetes" in 1887. Meanwhile a second edition of a portion of Cooke's "Handbook" was being issued as a supplement to "Grevillea," but confined exclusively to the *Agaricini*. With the exception of Plowright's "British Uredineæ" published in 1889, all the rest of the orders contained in the "Handbook" remained as they were in 1871. The unrevised portions included the *Pyrenomycetes*, or Sphæriaceous fungi; the *Sphæropsideæ*, or imperfect Pyrenomycetes; and the *Hyphomycetes*, or moulds. Hence the announcement of a complete work which should include *all* the British fungi, of whatever denomination, brought up to date, did not come as a surprise.

The volume before us consists of 430 pages, and professes to be the first of three volumes, which are to contain the whole "British Fungus Flora" in full, and upon the same plan as this first volume. We have heard of wonderful feats of "strong men," but these will be nothing in comparison to the feat which is ostensibly promised on the title-page, *when* it is accomplished. In our simplicity we should have calculated *six* volumes as nearer the minimum. If the result proves to be *less*, we shall be content to bear the odium of a false prophet. We may premise that the author who has undertaken the present work is eminently fitted to carry it out successfully, inasmuch as he is a practical field naturalist, with independent views, and by no means afraid of hard work.

To return to the volume in question, we must recognize clearness of typography, and distinctness in the isolation of species, which will facilitate reference and increase its practical utility. The illustrations are rather rough outlines, but quite sufficient for practical purposes, and will exhibit the distinctions between the several genera as far as illustrations can do it. Of the systematic arrangement we are not prepared to speak so highly, but perhaps some may consider this a matter of detail. The contents may be summarized thus, in the order of their appearance. The *Gastromycetes*, or puff-ball fungi, commencing with the subterranean species, followed by the *Sclerodermeæ* and the *Nidularieæ*, then the *Lycoperdeæ*, concluding with the *Phalloideæ*. These are succeeded by the *Hymenomycetes*, in like manner inverted, commencing with the *Tremellineæ*, and backwards through the other families to the *Agaricini*, which are commenced in the last 120 pages, but not half completed. We imagine that half another volume will be required to complete the *Basidiomycetes*.

Under ordinary circumstances, when we take up a flora, we are accustomed to meet with the adoption of either one of two methods. The one consists of a regular sequence, from what the author regards as the highest developments in his congeries to the lowest; the other an equally regular sequence from the lowest to the highest. This is conventional, but the present book is not conventional. In one sense there undoubtedly is a regular sequence from the lowest forms to the highest in the *Basidiomycetes*, which this volume contains; but we must not infer that Mr. Massee regards the *Basidiomycetes* as the lowest order of Fungi, or that he commences with the simplest organisms, proceeding upwards by regular gradations to the most complex, when he starts with the *Gastromycetes*. Undoubtedly our author has not made a special study of the puff balls in order to degrade them to the lowest rank. Hence we can only arrive at one conclusion, and that is, that such portions of the work have now been printed as were ready for the press, and no conclusions are to be drawn from the sequence adopted as a convenience, as if it were adopted by premeditation.

Continental mycologists have now for some time accepted the genera of the *Agaricini* as defined by Fries, with the exception of the large genus *Agaricus*, which Fries himself subdivided into numerous smaller groups as subgenera; but they have elevated all these smaller groups to the rank of genera, and placed them upon an equality with the other veritable genera of *Agaricini*. Against this metamorphosis we feel bound to contend, on the ground that the distinctions, although sufficient for the subdivision of a genus, are not of generic value, and that the genera so constituted are unnecessary, and of unequal value, with the old genera beside which they are placed. For instance, *Amanitopsis* differs only from *Amanitæ* in the absence of a ring; and *Annellaria* differs only from *Panæolus* in the presence of a ring. Let any one of practice and experience compare these pseudo-genera with *Coprinus*, *Cantharellus*, or *Schizophyllum*, and judge of what we say. For the first time these pseudo-genera now find a place in a British flora, and, although not of overwhelming importance, we cannot permit them to pass without protest.

Spore measurements are a recent addition to the diagnoses of *Hymenomycetes*, and, although we contend that they should be employed with caution and discrimination, it is very satisfactory that so much attention should have been given to them in this work. Not only does the spore vary in size in a given species in different seasons, but at different periods in the same year. This is certainly true in some species which have been tested, and should lead us to accept spore measurements as approximate rather than absolute.

In conclusion, we are bound to remark that this is a student's book, written with a full appreciation of the wants of a student, and giving all the information which a student might require. In all cases, whether under families, genera, or species, will be found just the details which the novice will be most anxious to obtain, and, although the study of these interesting but rather difficult plants has been of late somewhat upon the decline, we doubt not that it will revive and prosper by the aid of the new "British Fungus Flora," which will become the "text-book of British mycology."

M. C. C.

SOUTH AFRICAN SHELLS.

Marine Shells of South Africa: A Catalogue of all the Known Species, with References to Figures in Various Works, Descriptions of New Species, and Figures of such as are new, little known, or hitherto unfigured. By G. B. Sowerby, F.L.S., F.Z.S. Pp. 89, 5 pls. [drawn by the author]. (London, 1892.)

Since 1848, when Krauss published his well-known work, entitled "Die Südafrikanischen Mollusken," no such list as the one before us dealing with the Molluscan Fauna of this interesting and important marine province has appeared.

Krauss, who included the non-marine forms of the South African region in his work, recorded 403 marine species, of which 213 were considered to be peculiar to the province. Many other species have been subsequently cited or described as coming from that quarter, notably by E. von Martens and by our present author.

Conchologists undoubtedly owe much to Mr. Sowerby for thus bringing together within the small compass of this single volume, the scope and aim of which are sufficiently indicated in its title, the scattered records of the various species as known to him; but they will equally regret that the author did not include the whole molluscan fauna instead of confining himself to the testaceous forms, and thereby raise the work from the level of a mere shell-collector's catalogue to the rank of a work of reference of real scientific value.

Mr. Sowerby enumerates 740 species, and estimates that 323 of these are confined to South Africa, whilst 67 also occur in European seas, and 340 have been found on other coasts. Unfortunately, it is our disagreeable duty to point out that this record does not include "all the known species," and hence is not what the author fully intended it to be, viz., "as complete as possible." An important paper by Von Martens[1] appears to have been overlooked, for there are about thirty species named in it, including some which were then new, not mentioned by Mr. Sowerby. Still more remarkable is the omission of the new forms described by Mr. Watson in his report upon the Scaphopoda and Gastropoda, obtained during the voyage of the *Challenger*. Davidson's "Monograph of recent Brachiopoda," had it been more closely scanned, would have yielded not only two species reputed to have come from the Cape, but also *Terebratulina Davidsoni*, King, the type specimens of which, dredged on the Agulhas Bank, were passed on to their describer by Mr. G. B. Sowerby (the elder, we presume) in 1871.

A number of species have been recorded by Mr. E. A. Smith in an appendix to a "Report on the Marine Molluscan Fauna of the Island of St. Helena,"[2] as found there on what is locally known as "Sea-horn." This substance appears to consist of portions of a large species of Tangle, probably *Echlonia buccinalis*, which occurs at the Cape, whence it drifts to St. Helena. Some allusion should have been made to these forms. Hints might also have been gleaned from the same report, which deserves to be more widely known than seemingly it is, of undoubted South African species whose names do not appear in Mr. Sowerby's catalogue.

The presence of a good index, while it obviates the necessity, does not abolish the desirability of a good classification, and, in the present state of our knowledge in matters conchological, that of Woodward's Manual is hardly up to date; it is somewhat late in the day to find *Dentalium* still in its old place in the Gastropoda.

Some few changes in nomenclature are made in deference to the law of priority, and these are set forth at the end of the preface. Amongst them is *Ovula*, Bruguière, 1789 = *Ovulum*, Sowerby, &c., though, according to some, *Ovula* is itself a synonym for *Amphiperas*, Gronovius, 1781; *Calliostoma* is erroneously attributed to Bruguière instead of Swainson.

There are also some oversights in the text, as, for instance, "*Columbella cerealis*, Menke (Buccinum), Krauss ... = *C. Kraussii*, Sowerby," where, since Menke's name was given merely in MS., Sowerby's name stands, having four years' priority over Krauss's; *Triforis* is treated as though of the masculine gender; whilst the references to "figures in various works" require careful checking.

[1] "Ueber einige südafrikanische Mollusken nach der Sammlung von Dr. G. Fritsch." Jahrb. Deutsch. Malak. Gesell. 1874, pp. 119–146.
[2] Proc. Zool. Soc. 1890, pp. 247–317.

As regards the figures that accompany the work itself, it is a matter for regret that they cannot be commended. Few objects are more difficult to draw or require more skill in their delineation than do the shells of mollusca, and the amateur is rarely able to do them justice. The want of finish in the present instance is all the more noticeable from the contrast they afford to the rest of the "get up" of the work, which is admirable.

These shortcomings are not thus dwelt on in any captious spirit, but are pointed out in the friendly hope that a future edition of the work may shortly be forthcoming, in which the defects of the present one, compiled under great difficulties and at much disadvantage, may be made good and a really complete catalogue result.

$(BV)^2$.

OUR BOOK SHELF.

The Framework of Chemistry. Part I. By W. M. Williams, M.A. (London: George Bell and Sons, 1892.)

THIS is the first part of a book which has been specially written as a supplement to the oral lessons and experimental demonstrations given by a teacher. It is intended to contain nothing but what is absolutely necessary to give definite and precise impressions regarding the salient points of the lessons, all details relating to laboratory manipulation being omitted. The more important introductory facts, divested of theoretical considerations, are first discussed, then come "atoms and molecules," treated in an elementary fashion and leading the way to the explanation of the use of symbols and formulæ.

How the system adopted by the author will work out can only be ascertained when the other parts are to hand. So far as the information in the present volume goes, it is to a great extent useful and clearly stated.

Objection may be taken to the classification of solutions as mechanical and chemical, for, were it for no other reason, it is still a disputed point whether any solution may be considered a mixture.

The concise style of the book lends itself to incomplete statements. For instance, to say that one of the oxides of carbon "contains exactly twice as much oxygen as the other," is hardly accurate; a constant quantity of carbon is essential to the accurate conception of the facts. The most serious blunder made by the author lies in the confusion of force and energy. This is manifest in statements involving the conversion of "chemical force" into an "equivalent amount of heat" or of "electrical force," and culminates in the assertion that "Force, like matter, cannot be destroyed."

The Beauties of Nature, and the Wonders of the World we Live In. By the Right Hon. Sir John Lubbock, Bart. M.P., F.R.S. (London: Macmillan and Co., 1892.)

SO many writers of the present day adopt a pessimistic tone that a pleasant impression is always produced by Sir John Lubbock's genial and imperturbable optimism. In the present volume he undertakes to show how many sources of interest men might find in the world around them, if they would only take the trouble to train themselves to appreciate the scientific significance of ordinary facts. He begins with a study of animal life, and has much that is fresh and suggestive to say about various aspects of the subject. Then there are chapters on plant life, woods and fields, mountains, water, rivers and lakes, the sea, and the starry heavens. The volume is written in the clear, frank style with which all readers of Sir John Lubbock's books are familiar, and it ought to do much to foster among the class to which he appeals habits of careful and exact observation. His readers have the satisfaction of knowing that of the many things they may learn from him none will afterwards have to be unlearned.

Algebra for Beginners. By H. S. Hall and S. R. Knight. (London: Macmillan & Co. 1892.)

THIS work is intended as an "easy introduction" to the author's "Elementary Algebra for Schools," and, besides being treated on lines similar to those of the last-mentioned book, is published in a cheaper form. The idea throughout seems to have been to present the beginner with the practical side of the subject, and with this intention the examples are made as interesting as such examples can be. The usual sequence has not here been strictly adhered to; but a beginner will find that he will still be able to reach the "as far as quadratic equations" limit. It is needless to say that the explanations are stated in clear and simple language, while the examples are all new. That this book will be widely used is undoubted, for it will form an excellent forerunner to the more advanced one referred to above.

Introduction to Physiological Psychology. By Dr. Theodor Ziehen. Translated by C. C. van Liew and Dr. Otto Beyer. (London: Swan Sonnenschein and Co. 1892.)

IN reviewing the book of which this is a translation (NATURE, vol. xliv. p. 145), we pointed out that such a book was badly wanted in English. We are glad, therefore, to welcome a translation of Dr. Ziehen's work, which will serve well as an introduction to the new science of physiological psychology.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The *Volucellæ* as Examples of Aggressive Mimicry.

AN interesting point in the *Volucellæ* as examples of aggressive mimicry is the fact that they were first used to support the teleological theories of an earlier day, and were subsequently claimed by natural selection. Thus Messrs. Kirby and Spence speak of them (Second Edition, 1817, vol. ii., p. 223) as affording "a beautiful instance of the wisdom of Providence in adapting means to their end;" and after describing the resemblance of the flies to the bees, they continue, "Thus has the Author of nature provided that they may enter these nests and deposit their eggs undiscovered. Did these intruders venture themselves amongst the humble-bees in a less kindred form, their lives would probably pay the forfeit of their presumption." In this theory of Providence it is hard to see where the bees come in. In 1867, A. R. Wallace published an article on "Mimicry and other Protective Resemblances among Animals," which was in 1875 republished in his "Essays on Natural Selection." In this essay (p. 75 of the volume) he spoke of this interpretation as the only case in which an example of mimicry had been "thought to be useful, and to have been designed as a means to a definite and intelligible purpose." He accepts it as a product of natural selection, and since that time it has been constantly used as a well-known example of this principle, so well known, indeed, that the history of it became unnecessary in any publication where space was an object.

I neither originated the principle of aggressive mimicry nor the *Volucellæ* as examples of it, although I accepted, and still accept, both. Under these circumstances I must, in justice to Kirby and Spence and A. R. Wallace, repudiate the discovery of a significance I should have been proud to have made, but which was made, as a matter of fact, about half a century before I was born. It is only fair to these writers to say this, for Mr. Bateson, although mentioning Kirby and Spence, seems

throughout to give me the sole, or, at any rate, the chief, responsibility for both hypothesis and examples.

In writing my book I made great use of a very interesting series of specimens in the Museum of the Royal College of Surgeons, lately brought together by Prof. Stewart. The aggressive mimicry of the *Volucellæ* was illustrated in one of these cases, and I briefly described the contents of the case in the passage Mr. Bateson quotes. I was glad to give a few more details than those supplied by Mr. Wallace, and at the same time to mention examples which could be actually seen by readers; for I referred to the collection more than once. I was, however, anxious to obtain confirmation from one who had studied the Hymenoptera and their parasites much more minutely than I had, so I referred the proofs to Mr. R. C. L. Perkins, a most observant naturalist, specially interested in these insects. He made some valuable suggestions, but did not modify the account of the case in the Royal College of Surgeons. I think I may claim, therefore, that I took all reasonable precautions to avoid error in a part of the subject which had not then come under my own personal observation. Prof. Lloyd Morgan, in his interesting "Animal Life and Intelligence," has also mentioned this example, and figures the *Volucella* and *Bombus muscorum*. He tells me that his figures were copied from a case in the Natural History Museum, so that my selection appears to be supported by the two great biological museums of London.

Within a few weeks of the appearance of my book, I had found out the omission of the other banded humble-bees also mimicked by the *mystacea* variety of *Volucella bombylans*, and I showed one of these (I think *B. hortorum*) at a lecture given to the British Association at Leeds in 1890. I had intended, and intend, to repair the omission in any reprint that may be required.

There is, however, nothing inaccurate in the statement that *B. muscorum* is mimicked. We require something more than dogmatic assertions and question-begging metaphor of tabby-cat and fox to establish this as an error of the two museums and the two volumes which have followed them in this respect. Mr. Bateson appears to have been studying the literature of *Volucellæ* rather carefully: if he now extends his investigations to the perfect insects themselves, and compares the individuals in a series of moderate length, he will find that the *mystacea* variety differs much in the demarcation of its rings or zones, and also that the appearance of each individual varies with the direction from which it is observed. The less sharply-marked appearances resemble *B. muscorum*, the likeness being increased by a slight indication of zoning to be seen in the latter.

On July 7 of the present year I captured, in a wood near Newbury, a pair of the variety *mystacea* in copula. The male, the larger insect, was unusually indistinctly zoned. I have submitted the specimens to Mr. Verrall, who kindly tells me that the large male is certainly the variety *mystacea*, and he evidently thinks there is nothing remarkable about it. On the other hand, the female, which was unusually small, is more interesting, being somewhat an intermediate variety. As, Mr. Verrall informs me, Rondani has made about a score of intermediate species, this little capture of mine may turn out to be of interest, and it is comforting in a controversy of this kind to be able to add one fresh observation which may be of some use, if only in the way of confirmation.

Now as to the statement, in which no ambiguity was intended, that the two varieties lay in the nests of the bees they respectively mimic. This was, as Mr. Bateson says, a very general impression, the impression of naturalists who knew these insects far better than I did, an impression which had already been expressed in the case at the College of Surgeons. If I was mistaken in adopting it, was it not well that I made the mistake, if by its means the general impression should be corrected, having in my book assumed a tangible shape? What man who cares for the advance of science more than for his own advancement would regret to have made a mistake under such circumstances?

But I am not yet satisfied that the impression is not substantially correct. I do not regard the dimorphism of *V. bombylans* as the unique phenomenon it appears to be in the opinion of Mr. Bateson. I fail to see any essential biological difference between it and the dimorphism of many Lepidopterous larvæ—a dimorphism which extends into the pupal stage of most species of the genus *Ephyra*—or between it and the distinct types into which certain butterflies of the genus *Kallima* can be divided according to the colouring of the under sides of the wings, or certain moths of the genus *Triphæna* according to that of the upper sides of the upper wings. But we know that in those cases which have been tested, while the majority of the offspring resemble the variety to which the parents belonged, a certain proportion follow the other variety, and when the parents belong to different varieties the offspring are more equally divided. It is therefore only to be expected, so far as our present knowledge goes, that both varieties should emerge from the same nest. The important thing to be ascertained, from the point of view of the theory of aggressive mimicry, is not the colour of the offspring which emerge, although this is of high interest on other accounts, *but the colour of the parents which enter*. It might be supposed that Mr. Bateson would have understood this, but it is perhaps too much to expect from a critic who is so aggressively uninterested.

It would be interesting to know the grounds upon which Mr. Bateson considers the dimorphism of *V. bombylans* to be almost unique. At present he contents himself with assertions. If we were ever to return to the *régime* of authority and dogmatism in place of reason and experiment, Mr. Bateson's scientific position would be indeed assured.

Years ago I was satisfied that the evidence for the statement in my book was insufficient, and this, too, I had intended to modify when the opportunity occurred. In lecturing I have often alluded to the investigation as an interesting one, and only a fortnight ago suggested it to the members of the Natural History Society at Marlborough College. Two years ago I endeavoured to breed *Volucellæ* in the manner described by Mr. Bateson, I am sorry to say without success. I may therefore claim that the statement quoted by Mr. Bateson had produced no paralysis of effort on my part either as regards my own work or that which I have been able to suggest to others.

I may add that the upshot of this inquiry—even if it lead to the conclusion that both varieties lay indiscriminately in the nests of all the species they resemble—would not, in my opinion, remove the *Volucellæ* from their place as examples of aggressive mimicry, but the working of the principle would be more complex. I do not, however, propose to render myself liable to further sneers about "ingenuity" by discussing it on the present occasion.

Mr. Bateson's letter appropriately ends by putting into my mouth a defence I should never have advanced—a defence which was obviously inserted in order to impute discredit—and then proceeding to the easy task of demolishing it. Let me therefore say that a mistake is to me a mistake, whether in a volume intended for the public or a paper presented to a scientific society. Indeed, I regret the former more than the latter. Unfortunately, too, mistakes are more liable to occur in the volume, because the ground is wider, and passes in some directions into less familiar regions. But I can honestly say that I have always done my best to avoid mistakes, and that I correct them as the opportunity arises, in fresh papers or in reprints of volumes. And I derive much comfort from Mr. Phelps' dictum, which I am sure appeals to every one who works, that "people who never make mistakes never make anything." EDWARD B. POULTON.

Oxford, October 24.

P.S.—I wish to take this opportunity of correcting certain mistakes in my book ("Colours of Animals," Internat. Sci. Ser.), as it may be some time before the book can be reprinted, owing to the number of copies struck off.

Pages 49, 50.—Dr. Hurst informs me that my abstract of Weismann's work on seasonal dimorphism is wrong. This will be carefully reconsidered in any reprint.

Page 73.—I wish to withdraw the account of *Phrynocephalus*. Although the structures alluded to are probably alluring, there is not sufficient evidence as to the manner in which they are used.

Page 85.—Professor Howes calls my attention to the description of the nerve-terminations in pigment-cells.

Page 94, *et seq.*—Sir J. Ross should be Captain James Ross.

Page 105.—I ought to have added that Mr. Sharpe's conclusions are not accepted by Professor Newton.

Pages 142-146.—Mr. Bateson has shown that the white cocoons of *Saturnia* and *Eriogaster* are not due to the white backgrounds employed, but to disturbance of the larvæ. It is still probable that the principle holds in *Halias prasinana*.

Page 156.—For the above reason I withdraw the argument about the cocoons of *Rumia*, although I believe that it still holds if *H. prasinana* be substituted.

Chapters x., xi. should be read in connection with the experiments on Warning Colours since made by Mr. Beddard and published in his volume, "Animal Coloration."

Page 161.—The cockroach is not a good example. As Prof. Weldon pointed out to me, there is no evidence that its unpleasant smell renders it unfit for food. The hive-bee would be a better instance.

Page 193, line 7 from bottom.—*Fibrous* should be *fulvous*.

Page 203, line 6 from bottom.—For *suited for* read *bearing*.

Page 208, line 13 from top.—*Divert* should be *direct*.

Page 224.—I have since heard from Mr. Skertchly that he did not intend the argument which I quote at the bottom of the page to be taken seriously.

Page 236.—*Diadema bolina* should be *D. misippus*, and it and the *Danais* it mimics occur in *three* varieties, not in *two*. I owe this to Col. Swinhoe; the error was copied from Trimen.

E. B. P.

The Geology of the Asiatic Loess.

IN the spring and early summer of this year I had the opportunity, in company with Mr. S. B. J. Skertchly, of examining closely the loess deposits of Shantung, stretching from Chefoo to Tsinan, the provincial capital.

The investigation convinced us both that the original loess of China must be regarded as a marine deposit. Subsequent to the time of Mr. Skertchly's leaving the province, on June 17, I was able to supplement these conclusions by the discovery of a band of limestone rocks bored by pholades and crustaceans up to a height of about 1100 feet, above which line no indications of late marine action were visible. The rocks in the locality near Tsinan-fu are carboniferous limestones interbedded with dioritic porphyries, and are still horizontal and unbroken for some thousands of square miles, having received their present contour in pre-loess ages. The dip for hundreds of square miles in this locality seldom exceeds from 2° to 8°. These facts we hope to make the subject of a joint memoir.

The loess of China has, however, been traced almost continuously beyond the limits of the eighteen provinces to the foot of the Pamîrs. West of the Pamîrs loess occurs in the valley of the upper Oxus, probably in the Kizil Kum, and up to the Caspian, and its marine origin requires us to believe in the submergence within late geologic time of the greater part of Central Asia. Most geologists recoil at such a suggestion, and I am in a small minority in accepting the view that the present distribution of ocean and continent is of very recent date. I may, however, in condonation of heterodox views, refer to the position of the argument with regard to the alleged shifting of the terrestrial axis of rotation, which has within the last few years entered on a new phase. When some years ago I presented these views to the Council of the Geological Society of London they were scouted as utterly untenable. Since that time, while English astronomers have held the view that practically the axis of rotation has undergone, within the limits of observation, no change, American astronomers have come to the conclusion that a secular movement is actually in progress. My own geological observations in Europe, North America, and Asia have led me to infer that the North Pole has within recent geological time shifted, and that a shift is in all probability in progress at the present time along a line following approximately the direction of the 70th meridian of west longitude. This shift is not to be taken to involve a change in the direction in celestial space, but is rather a rolling of the earth over its axis, the latter remaining practically stationary.

Dynamical causes sufficient to account for the change of position of the terrestrial poles, and in consequence of the parallels of latitude, seem to me to be at work. Prof. G. Darwin has calculated the probable change in the position of the pole due to an elevation of the bed of the Pacific Ocean, but no one has touched the converse effect of the change of the pole on the relative levels of the oceans and continents. In addition to the cause suggested in the possible elevation of large tracts of continental land, there are other influences at work tending in the same direction. The different distribution of the large masses of ice around the poles, which probably varies within somewhat large limits, and the slow disturbance of equilibrium resulting from the growth of deltas and deep sea deposits, have frequently been adduced. More important still is perhaps the differential influence of tidal friction in retarding the rotation, the effect of which must be sensibly unequal in the two hemispheres north and south of the equator; another cause may be looked for in the action of aerial currents, the effect of which in the northern hemisphere as containing greater masses of elevated land must be greater.

Another potential cause of shifting has never, that I am aware of, been formulated. Although at present of comparatively small influence, it must at various geological periods have been of great importance. It leads on to dynamic considerations of tidal energy beyond the compass of a letter to explain. The relative part played by the sun and moon, as deduced from gravitational formulæ, does not quite agree with the observed phenomena of our daily tides. It is believed by many that the ordinary lunar tide, affecting mainly the oceanic envelope, is complicated by the presence of a terrene tide largely influenced by the sun, and that the earth does to an appreciable extent yield twice in the twenty-four hours to the deforming force of solar gravitation. So long as this oscillation takes place at regularly recurrent intervals no energy is wasted. Should, however, a sudden snap occur, breaking the rhythm of the oscillation, some energy is evidently spent, and this can only be made up from the *vis viva* of rotation. Such snaps do occur occasionally; the regular oscillation is momentarily suspended, and the waters of the ocean rush in to restore the equilibrium. This is the well-known "tidal" wave that so frequently occurs in connection with earthquakes.

Such a snap on the equatorial line would simply retard the rotational period generally. North or south of this line, as the moments of rotation would be instantly unequal, the sphere would roll over its axis of rotation, and a shift in the position of the poles occur. The earth is not a perfectly rigid mass. Were it as rigid as steel, the interior within a depth of 200 miles would yet, under the pressure of gravitation, behave as a liquid; a shift in the pole would then be met either by a corresponding shift in the equatorial protuberance, or a change in the ocean level; or, more probably, by a compound action of both. In the latter case, to fulfil the conditions of equilibrium, the ocean surface in the neighbourhood of the new equator would rise, and if the shift were sufficiently great, would overflow the lowlands. If the equator, in the longitude of Central Asia, had at any former time passed north of its present position, and the rock masses of the Continent had not been elevated, a mid-Asian sea must have resulted. The undisturbed position of the carboniferous rocks, and the plain evidence that the surface sculpturing of the rocks was of pre-loess age, show that the process was unaccompanied by violent movements.

The theory of the shift of the earth over its momentary axis accounts better than any other for the geological condition of polar lands, and I venture to state it again in brief, as on this occasion the initiative has come from the astronomers, not the geologists.

THOS. W. KINGSMILL.

Shanghai, China, August 20.

Note on Mr. Kingsmill's paper.

I think it will be difficult for Mr. Kingsmill to adduce evidence of geological changes large enough to produce any considerable shifting of the position of the principal axes of the earth, and accordingly I should feel sceptical as to a theory which postulates that such change has been sufficient to explain considerable changes of climate.

With respect to a later part of the paper, I am entirely at variance with his views. As far as I know "the relative part played by the sun and moon" in producing oceanic tides is in exact accordance with gravitational formulæ.

The existence of a terrene tide is a matter of speculation, but, as the earth cannot be perfectly rigid, it must exist to some extent. The amplitude of the lunar terrene tide must certainly bear to that of the solar the same ratio that holds in the case of oceanic tides, and there is no reason, that I know of, for attributing a greater efficiency to solar action in the case of the deformation of the solid portion of the earth.

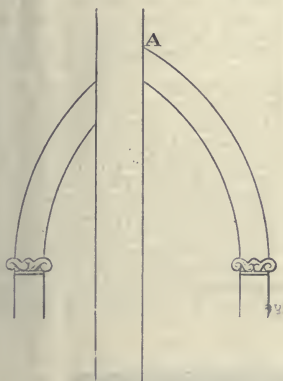
I am quite unable to follow the argument by which the so-called "tidal" wave produced by earthquake shock is supposed to produce a retardation of the earth's rotation.

October 21.

G. H. DARWIN.

Optical Illusions.

REFERRING to the article in NATURE for October 20, may I mention a rather common optical illusion which I do not remember to have yet seen in print. If a gothic arch is unequally divided by a space between two vertical parallel lines, these lines will not only seem to diverge slightly where they intersect the lines of the arch, but the arch itself is caused to appear as if one half had slipped bodily down from the other to an extent



equal to its own thickness. In the figure given above it is impossible to believe that but for the intervention of the vertical interlinear space the two halves would be seen to meet perfectly with the apex at A. This illusion is worth the notice of architects who desire to avoid the disquieting effect upon the eyes of observant persons which is produced by the intersection of the chancel arch of a church by an intervening pillar.

28 Mount Park Crescent, Ealing, W. R. T. LEWIS.

A Remarkable Rainfall.

THE rainfall here of October has been so remarkable that it seems worth while to place it on record in your columns. Rain fell on twenty-five days during the month, making a total fall of 10·32 inches. As the annual rainfall on an average of eleven years is 31·10 inches, it will be seen that very nearly one-third of this amount fell in one month. This is by far the highest amount I have recorded since I began to make records in January, 1878, the next highest month being August, 1879. On that occasion five inches fell in thirty hours on the 17th and 18th, and many bridges were carried away in Flintshire and Denbighshire, but the total fall for the month was only 7·89 inches. Dr. Nicol, of Llandudno (six miles from here), who has registered the rainfall since, and including 1861, informs me that it amounted last month to 8·56 inches there, this also being the highest month he has ever recorded.

In September rain fell on twenty-three days, and though the total fall was only 3·77 inches, yet the constant rain, combined with an unusually low temperature (the mean maximum being only 56°·6, and the highest shade temperature 67°·4, against 64°·6 and 81°·2 respectively in 1891), made it almost impossible to get in the harvest. ALFRED O. WALKER.

Nant-y-Glyn, Colwyn Bay, November 5.

On a Supposed New Species of Earthworm and on the Nomenclature of Earthworms.

IN yesterday's NATURE I find that the Rev. Hilderic Friend has again given the name *L. rubescens* (Friend) to a supposed new species of earthworm. This worm appears to me to be identical with *Enterion festivum* (Savigny), described under the name *Lumbricus festivus* by Rosa. Though comparatively rare, it is by no means new, nor even new to Britain, though I know of no published record of its occurrence here. I met with two or three specimens among the worms supplied to me when I was working at the chapter on Lumbricus in "Marshall and Hurst," and identified them subsequently by the help of Rosa's table. At the time I took them for mere varieties, and put them into a bottle for future study. I believe the specimens are now in the possession of Dr. Benham, who has entirely overlooked the species in his "Attempt to Classify Earthworms" (*Quart. Journ. Micr. Sci.* xxxi.).

The specific name *terrestris* must also, it appears to me, be dropped. Linnæus did not define a species under that name, but applied it to what are now universally regarded as several distinct species. The species so called by Mr. Friend was, I believe, first defined by Savigny under the name *Enterion herculeum*. The diagnostic characters of the species are given by Rosa in his useful table of the species ("I Lumbricidi dei Piemonte," p. 25), and he calls it *Lumbricus herculeus*, to which name the usual rules of nomenclature bind us.

I would therefore suggest the following alterations in Mr. Friend's "Chart of the Genus Lumbricus":—

1. For "Terrestris (Linn.)" read "herculeus (Sav.)"
2. For "Rubescens (Friend)" read "festivus (Sav.)"

Owens College, October 28. C. HERBERT HURST.

Ice Crystals.

DURING the cutting of the formation for a railway I observed on Tuesday morning, the 18th inst., a peculiar series of ice crystals. The ground is composed of arenaceous clay largely mixed with sand and small gravel, and is of a very open nature, the surface being covered with moorland grass, rushes, and coarse ferns. These crystals were only found in a length of about nine feet, the ground on both sides of the patch being hard frozen.

These crystals were acicular, and sprang from a base of very porous opaque ice, but every needle was entirely free and distinct throughout its height, and at first sight appeared to be bound together with two bands, one at one-third and the other at two-thirds of the height. A closer examination proved that the band appearance was due to a slight enlargement of the crystals at these points, the ice being opaque, whilst the needles were perfectly translucent.

The average height of these crystals was about one inch, the needles having a diameter of about $\frac{1}{80}$th part of an inch, and were grouped together in clusters of forty or fifty, forming an irregular square of about $\frac{1}{4}$-inch on the side. Some of these crystals were growing vertically from the ground, others springing out horizontally from the side of the cutting, and were either straight, curved, or bent round forming a half circle. This morning the same form of crystals existed, but were much larger, being fully two inches long. On both occasions the air was calm and clear, the min. ther. reading 30° on the 18th, and 24° to-day.

Lesmahagow, October 25. C. M. IRVINE.

Lunar Craters.

THE letter and illustration offering a suggestion as to the formation of lunar craters remind me of an experiment I once saw during a chemical lecture, bringing out the same point very clearly.

A shallow dish containing a layer of damp sand, $\frac{1}{2}'$, was flooded with 1-inch coating of Paris plaister, of the consistence of cream, and the dish set to dry over a Bunsen flame.

As the plaister set, the surface was pitted with crater-like holes, formed by the escape of steam from the sand at the bottom of the dish, giving a perfect representation of a lunar surface.

As some of your readers might care to try this experiment, I take the liberty of sending you this "recollection."

M. H. MAW.

Walk House, Barrow-on-Humber, Hull, Nov. 7.

A Fork-tailed Petrel.

THE occurrence of a Fork-tailed Petrel as far inland as Macclesfield may perhaps interest some of the readers of NATURE.

It was picked up by a man on the 11th ult., two days after the stranding of the *Sirene* in a gale at Blackpool, and being unacquainted with the species he sent it to me as a curiosity. I identified it as a Fork-tailed Petrel, and Mr. J. H. Salter, of Aberystwyth College, has kindly confirmed this decision.

Some of the feathers on the forehead are tipped with white. Does this indicate a young bird, as I can find no mention of it in any of the plumage descriptions that I have seen?

NEWMAN NEAVE.

Rainow, near Macclesfield, November 5.

THE ORIGIN OF THE YEAR.[1]

III.

IN the previous articles I have endeavoured to show that the Egyptians had the Sirius year and the vague year so related to each other that the successive coincidences of the 1st Thoth in both years took place after intervals of 1460 Sirian years. With a real year, the length of which would be brought home to them by the regular recurrence of the solstices and Nile flood (to say nothing of the equinoxes) and the year of 360 days which they would soon find to be quite artificial and unreal; they would be much more likely to refer the dates in the artificial year to the real one, than to take the opposite course, and, as I have shown, the artificial dates would sweep backwards through the real ones. Such a method of reckoning, however, would be useless for calendar purposes, as they not only wanted to define the days of the year but the years themselves, and I pointed out that something more was necessary, and that an easy way of defining *years* would be to conceive a great year, or *annus magnus*, consisting of 1460 years, each "day" of which would represent four years in actual time; and further to consider every event, the year of which had to be chronicled in relation to others to take place on the day of the heliacal rising of Sirius or the nearly coincident Nile flood, which, was employed to mark the first year of each series of four.

Now as a matter of fact it is known (I have the high authority of Dr. Krall for the statement) that each king was supposed to begin his reign on the 1st Thoth (or 1st Pachons) of the particular year in which that event took place, and the fact that this was so supports the suggestion we are considering. During the reign its length and the smaller events might be recorded in vague years and days so long as the date of its commencement had been referred to a cycle.

We have next to consider more especially the vague year.

One argument which has been used to show that a vague year was not in use during the time of the Ramessids has been derived from some inscriptions at Silsilis which refer to the dates on which sacred offerings were presented there to the Nile-god. As the dates 15th of Thoth and 15th of Epiphi are the same in all three inscriptions, although they cover the period from Ramses II. to Ramses III.—120 years—it has been argued by Brugsch that a fixed year is in question.

Brugsch points out that the two dates are separated by 65 days; that this is the exact interval between the Coptic festivals of the commencement of the flow and the marriage of the Nile—the time of highest water; and

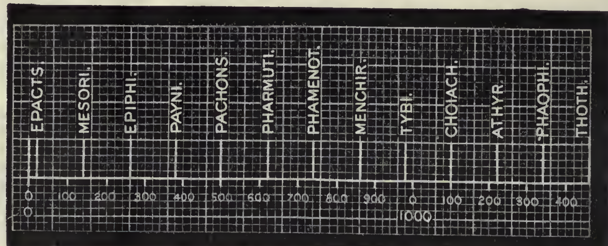


FIG. 5.—The distribution of the 1st of Thoth (representing the rising of Sirius) among the Egyptian months in the 1460 year Sothic cycle.

as we shall see, occurred, at different periods of Egyptian history, on the 1st Thoth and 1st Pachons.

A diagram, which may here be repeated, was given to show how such a system would work. From any coincidence of 1st Thoth (or 1st Pachons) in both the Sirian and the vague year, since the vague year is the shorter, the 1st Thoth (to deal only with Thoth) of the vague year would recede; so that in such a cycle it would fall first among the Epacts, then in Mesori, and so on through the months, till the next coincidence was reached.

The diagram will show how readily the cycle year can be determined for any vague year. If for instance the 1st Thoth in the vague year falls on 1 Tybi of the cycle, we see that 980 years must have elapsed since the beginning of the cycle, and so on.

Here, then, we have a true calendar system; if the Egyptians had not this, what had they?

Such a calendar system as this it will be seen, however, is good only for groups of four years. Thus during the first four years of a cycle the 1st Thoth vague would happen on 1st Thoth of the cycle, during the next four years on the 5th Epact, and so on.

Now a system which went no further than this would be a very coarse one. We find, however, that special precautions were taken to define which year of the four was in question. Brugsch[2] shows that a special sign that, therefore, in all probability these are the two natural phenomena to commemorate which the offerings on the dates in question were made.

But Brugsch does not give the whole of the inscription. A part of it, translated by De Rougé,[1] runs thus:—

"I (the king) know what is said in the depot of the writings which are in the House of the Books. The Nile emerges from its fountains to give the fullness of life-necessaries to the gods," &c.

De Rougé justly remarks: "Le langage singulier que tient le Pharaon dédicateur pourrait même faire soupçonner *qu'il ne s'agit pas de la venue effective de l'eau sainte du Nil à l'une des deux dates précitées.*"

Krall (*loc. cit.* p. 51) adds the following interesting remarks:—"Consider, now, what these 'Scriptures of the House of Life' were like. In a catalogue of books from the temple of Edfu, we find, besides a series of purely religious writings, 'The knowledge of the periodical recurrence of the double stars (sun and moon),' and the 'Law of the periodical recurrence of the stars.'

"... The knowledge embodied in these writings dated from the oldest times of the Egyptian empire, in which the priests placed, rightly or wrongly, the origin of all their sacred rolls" (cf. Manetho's 'History," p. 130).

Now to investigate this question we have to approach some considerations which at first sight may seem to be

[1] Continued from vol. xlvi. p. 107.
[2] "Matériaux pour servir à la reconstruction du calendrier," p. 29.

[1] "Aeg. Zeit," 1886, p. 5, quoted by Krall.

foreign to our subject. I shall be able to show, however, that this is not so.

Imprimis we must remember that it is a question of Silsilis, where we know both from tradition and geological evidence, in ancient times the first cataract was encountered. The phrase "The Nile emerges from its fountains" would be much more applicable to Silsilis, the seat of a cataract than as it is at present. We do not know when the river made its way through this impediment, but we do know that after it took place and the Nile stream was cleared as far as the cataract that still remains at Elephantine, a Nilometer was erected there, and that during the whole of later Egyptian history at all events the time of the rise of the river has been carefully recorded both there and at Rhoda.

From this it is fair to infer that in those more ancient times the same thing took place at Silsilis; if this were so the reason of the record of the coming of the inundation at Silsilis is not far to seek, and hence the suggestion lies on the surface that the records in question may state the date of the arrival *in relation to Memphis time*.

So far in my inquiries I have not been able to find a complete discussion of the influence upon local calendars, in different parts of the Nile valley, of the variations of the phenomena upon which the Egyptians depended for the marking of New Year's day.

If the *solstice* had been taken alone, the date of it would have been the same for all parts of the valley; but certainly the solstice was not taken alone, and for the obvious reason that they wanted something to warn them of the Nile rise, and in the lower reaches of the river the rise precedes the solstice.

Nor was the heliacal rising of Sirius taken alone.

As we have seen, according to Biot the heliacal rising of Sirius *at the solstice* took place on July 20 (Julian) in the year 3285 B.C.; and according to Oppolzer, it took place on July 18 (Julian) in the year 3000 ± B.C.

But this is too general a statement, and it must be modified here. There was a difference of 7 days in the date of the heliacal rising, according to the latitude, from southern Elephantine and Philæ, where the heliacal rising at the solstice was noted first, to northern Bubastis. There was a difference of four days between Memphis and Thebes, so that the connection between the heliacal rising and the solstice depended simply upon the latitude of the place. The further south, the earlier the coincidence occurred.

Here we have an *astronomical* reason for the variation in the date of New Year's day.

But it was chiefly a question of the arrival of the Nile flood, and the date of the commencement of the Nile flood was by no means common to all parts of Egypt!

I cannot find any statement of the dates of the arrival of any one Nile flood at places between Elephantine and Cairo. Dr. Wallis Budge[1] states: "The indications of the rise of the river may be seen at the cataracts as early as the end of May."

Now if we take the 1st cataract to be here meant, and deal with May 31; since the average day of arrival of the inundation at Cairo is 3 days after the solstice—that is June 20 (Greg.)—we have 24 days for the flood-travel for the 600 miles between Elephantine and Cairo, four-fifths of a month elapsing between the times at which the Green Nile colours the pool at Syene below the Cataracts, and the river at Memphis; so that the further south, the earlier the flood was noted. This gives us about a mile an hour. This certainly seems too slow.

But if we assume 16 days, this would give us about 15 days between Silsilis and Cairo, and 12 days between Thebes and Cairo, taking Cairo to represent the ancient Memphis. Now this represented a difference in the new year's days of different places, compared to which our modern differences of local time sink into insignificance, for they only touch hours of the day; and the reason that I have referred to them here is to point out that if the assumption made is anything like accurate, if, for instance, in Pepi's time a Nile rise were observed at Silsilis, there might easily be a difference of 15 days between the rise of the Nile at Silsilis and the Memphic 1st of Thoth. If both at Silsilis and Memphis the Nile rise marked 1st Thoth, the day of the rise at Memphis would correspond to 15th Thoth at Silsilis, so that a king reaching Silsilis with Memphis local time, would be struck with this difference, and anxious to record it, may not this then have been the important datum recorded in the sacred books? If so, it would not touch the question of the fixed or vague year at all.

Let it, then, be for the present conceded that there was a vague year, and that at least some of the inscriptions which suggest the use of only a fixed year in these early times may be explained in another way. I do not say the above explanation is the correct one, for the assumption of 16 days may be wrong, even if difference in the dates of the heliacal rising at the two places be taken into account.

The dates we have found—trying to take the very simplest way of writing a calendar in pre-temple times, and using the calendar inscriptions in the most natural way—are for the coincidence of the heliacal rising of Sirius at, or near, the solstice—

270 B.C.
1728 B.C.
3192 B.C.

Now here we meet with a difficulty which, if it cannot be explained, evidently proves that the Egyptians did not

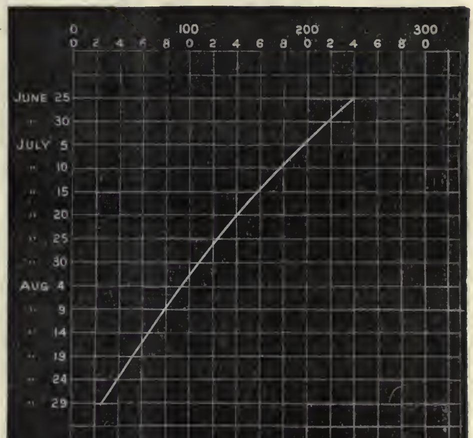


FIG. 6.—Julian dates of the 1st of Thoth (vague) from 23 A.D. to 240 A.D.

construct and use their calendar in the way we have supposed.

We have it on the authority of Censorinus that a Sothic period was completed in 139 A.D., and that there was then a vague year in partial use. It is here that the work of Oppolzer is of such high value to us. He discussed all the statements made by Censorinus, and comes to the conclusion that his account is to be depended upon. It

[1] "The Nile," p. 46

has followed from the inquiries of chronologists that in this year the 1st of Thoth took place on July 20 (Julian), the date originally of the heliacal rising of Sirius, the beginning of the year.

This being so, then, in the year 23 A.D.—in which the Alexandrine reform of the calendar, of which more presently, was introduced—the 1st of Thoth would take place on August 29, a very important date. Censorinus also said that in his own time (A.D. 238) the 1st of Thoth of the vague year fell on June 25. Fig. 5 will show the connection of these three dates in reference to the vague year. The relations of the statements made as to the years 139 and 238 are very clearly discussed by Dr. Oppolzer.

Oppolzer, then, being satisfied as to the justice of taking the year 139 A.D. as a time of coincidence of the fixed and vague years—the latter being determined alone by the heliacal rising of Sirius, and, be it remembered, not by the solstices—calculated with great fulness, using Leverrier's modern values, the years in which, in the various Egyptian latitudes, chiefly taking Memphis (lat. 30°) and Thebes (lat. 25°), the coincidence between the two Thoths occurred in the previous periods of Egyptian history. He finds these dates for latitude 30° as follow :—

	Julian year.	Historical year.[1]
0 ...	− 4235 ...	4236
1 ...	− 2774 ...	2775
2 ...	− 1316 ...	1317
3 ...	+ 139 ...	139
4 ...	+ 1591 ...	1591
5 ...	+ 3039 ...	3039

Now the date which Oppolzer gives for the coincidence which is nearest the date we had previously determined at 270 B.C. is 139 A.D. There is a difference of 409 years.

The question is, Can this fundamental difference be explained? I think it can.

In the first place, it is beyond doubt that, in the interval between the Ramessids and the Ptolemies, the calendar, even supposing the vague year to have been used and to have been retained, had been fundamentally altered, and the meanings of the hieroglyphics of the tetramenes had been changed—in other words, the designations of the three seasons had been changed.

On this point I quote Krall in a note.[2]

The three hieroglyphic signs used for the tetramenes are supposed to represent water, flowers, and a barn, and the natural order would be that the first should represent the inundation, the second the sowing which succeeds it, and the last harvest time. If this be conceded, the initial system would have had the month Thoth connected with the water sign, as Thoth in early Egyptian times was the first inundation month. But in the times of the Ramessids even this is not so. Thoth has the sowing sign assigned to it. In the time of the Ptolemies the flood is no longer in Thoth, but in Pachons, and Pachons has the barn sign attached to it, while the month Thoth is marked by the water sign, thereby bringing back the hypothetical relation *between the name of the month and the sign*, although, as we have seen, Thoth is no longer the flood month.

Egyptologists declare that all or at least part of this change took place between the periods named; they are undoubtedly justified as regards a part.

At one point in this interval we are fortunately supplied with some precise information. In the year 238 B.C. a famous decree was published, variously called the decree of Canopus and the decree of Tanis, since it was inscribed on a stone found there.

It is perfectly clear that one of the functions of this decree was to change, or to approve an already made change in, the designation of the season or tetramene in which the inundation commenced, from Thoth to Pachons.

Another function was to establish a fixed year, as we shall see presently. We must assume then that a vague year was in vogue prior to the decree. Now the decree tells us that at its date the heliacal rising of Sirius took place on 1 Payni. Assuming that this date had any relation to the system we have been considering, the cycle to which it belonged must have begun

Days.
5 Epacts
30 Mesori
30 Epiphi
30 Payni
—
95 × 4 = 380 years previously; that is, in the year 618 B.C.

Now here at first sight it would seem that the Sothic cycles we have been considering have no relation to the one now in question; for, according to my view, the last Sothic cycle began in 1728 B.C.

A little consideration, however, will lead to the contrary view, and show that the time about 600 B.C. was very convenient for a revision of the calendar.

In the first place nearly a month now elapsed between the coming of the flood and the heliacal rising; and in the second, by making the year for the future *to begin with the flood*, a change might be made involving tetramenes only.

Thus, commencement of cycle	...	1728 B.C.
Epacts	5	
Two tetramenes ...	240	
Month between flood and rising of Sirius ...	30[1]	
	275 × 4 =	1100
		628 B.C.

Nor is this all. A very simple diagrammatic statement will show what might also have happened about 618 B.C.

[1] It should be observed that a distinction is made between the Julian and the historical year. This comes from the fact that when astronomical phenomena are calculated for dates B.C., it must be remembered that chronologists are in the habit of designating by 1, or rather by − 1, the first year which precedes the instant of time at which the chronological year commenced, while astronomers mark this year in their tables by 0. It follows, therefore, that the rank of any year B.C. is always marked by an additional unit in the chronological dates. For the Christian era, of course, chronologists and astronomers work in the same way. The following table, given by Biot, exhibits the connection between these two methods. In the latter Biot shows the leap-years marked B, and the corresponding years in the Scaligerian chronological period are also given.

Dates of Julian Years commencing on January 1.

According to Chronologists.	According to Astronomers.	Corresponding years of the period of Scaliger.
−6	−5	4708
−5B	−4B	4709
−4	−3	4710
−3	−2	4711
−2	−1	4712
−1B	−0B	4713B
Physical instant when the era commenced.		
+1	+1	4714
+2	+2	4715
+3	+3	4716
+4B	+4B	4717B
+5	+5	4718

[2] *Loc. cit.* p. 29. "It is well known that the interpretation of the seasons and the months given by Champollion was opposed by Brugsch, who propounded another, which is now universally adopted by experts. Something has happened here which is often repeated in the course of Egyptian history —the signs have changed their meaning. Under the circumstance that the vague year during 1461 years wanders through the seasons in a great cycle, it is natural that the signs for the tetramenes should have changed their significations in the course of millenniums.

"While Thoth was the first month of the inundation in the documents of the Thutmosids and Ramessids, we have in the time of the Ptolemies the month Pachons as the first month of the flood season. Whilst Brugsch's explanation is valid for the time of the Ramessids, it is not so for that of the Ptolemies, to which Champollion's view is applicable."

[1] Probably too great a value by 2 or 3 days.

if a reformer of the calendar (and one especially of conservative tendencies) appeared upon the scene, who believed that the ancient sign for the inundation-tetramene was the water sign, and that the ancient name was Thoth. Finding the cycle beginning in 1728 with the signs as shown—

1728 B.C. Thoth, Phaophi, Athyr, Choiach, Tybi, Menchir, Phamenot, Pharmuti, Pachons, Payni, Epiphi, Mesori

when starting fresh, he would seize the opportunity of effecting a change, not only by dealing with a tetramene, but he would change the names of the tetramenes allocated to the signs.

B.C. 618 Thoth, Phaophi, Athyr, Choiach, Tybi, Menchir, Phamenot, Pharmuti, Pachons, Payni, Epiphi, Mesori

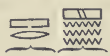
As Krall remarks, it was almost merely a question of a change of the sign! It really was more, because the new tetramene began with the flood.

Assuming this, we can see exactly what was done in 238 B.C., *i.e.* about 380 years later. We have seen that the 380 years is made up of

5 Epacts
30 Mesori
30 Epiphi
30 Payni

95 × 4 = 380

the heliacal rising of Sirius occurring on 1 Payni, having swept backwards along the months in the manner already explained. We had then—



B.C. 238 Pachons, Payni, Epiphi, Mesori, Thoth, Phaophi, Athyr, Choiach &c.

To sum up, so far as we have gone we have the three inscriptions at Philæ, Elephantine, and the still more ancient one of Pepi, indicating on the simple system we have suggested beginnings of Sothic cycles on the 1st Thoth about the years

$$\left.\begin{array}{r}270\\1728\\3192\end{array}\right\}\text{B.C.}$$

On the other hand, we have the decree of Canopus, giving us by exactly the same system a local revision of the Calendar about 600 B.C. I say *about* 600 B.C. because it must be remembered that a difference of $2\frac{1}{2}$ days in the phenomena observed will make a difference of 10 years in the date, and we do not know in what part of the valley the revision took place, and therefore at what precise time in relation to the heliacal rising the Nile-rise was observed.

Whenever presumably it took place, New Year's day was reckoned by the Flood, and the rising of Sirius followed nearly, if not quite, a month afterwards. The equivalent of the old 1st Thoth was therefore 1 Payni. In months, then, the old 1st Thoth was separated from the new one (= 1 Payni) by 3 months (Payni, Mesori, Epiphi) and the Epacts.

In this way, then, we can exactly account for the difference of 409 years referred to above as the dates assigned by Censorinus and myself for the beginning of the Sirius cycle.

Difference between 270 and 239	=	31 years.
3 months = 90 days × 4	=	360 ,,
5 epacts × 4	=	20 ,,
		411 ,,

The difference of two years is equal only to half a day!

It seems, then, pretty clear from this that the suggestion I have ventured to make on astronomical grounds may be worth consideration on the part of Egyptologists. If our inquiries have really led us to the true beginnings of the Sothic periods, it is clear that those who informed Censorinus that the year 139 A.D. was the end of a cycle omitted to tell him what we now can learn from the decree of Tanis.

J. NORMAN LOCKYER.

(*To be continued.*)

TECHNOLOGICAL EXAMINATIONS.

THE report of the results of the Technological Examinations, held this year under the direction of the City and Guilds of London Institute, has a special interest, seeing that after this year the system of payment on results in connection with all classes outside the Metropolis will be discontinued. There is no doubt that the offer of payment to teachers helped very greatly in 1879 to stimulate the formation of technical, as distinct from science, classes, and the great extension of this work of the Institute is largely due to the offer then wisely made of contributing towards the cost of instruction. The tables furnished in the report, and the diagram of results, are very interesting as showing the great development of these trade classes. Since 1880 the number of candidates for examination has increased more than tenfold, the numbers being 816 in 1880 and 8,534 in 1892. In 1885 there were 263 technological classes in different parts of the country, and in the session 1891–2 this number had increased to 610. There is, of course, a corresponding increase in the number of students in attendance at these classes. In 1881 the number of students was 2,500, this year it was 16,565. This record of progress is certainly satisfactory, and particularly so, seeing that prior to 1891 there was no sort of organization to carry on the work of directing and assisting technical classes for artisans in different parts of the country. As a pioneer movement, the work of the City Guilds Institute has been eminently successful, and many of the Technical Schools which have now been brought under the control of County Councils undoubtedly owe their origin to the technological classes promoted by the City Guilds. The question now demanding attention is the future of these classes. Much is to be said in favour of associating them more closely with the science classes, which are held in the same schools; but what is wanted for the permanent improvement of such classes is a system of efficient inspection by persons competent to advise County Councils with respect to the important work now under their control.

From the report and programme it appears that year by year the Institute adds to the extent and efficiency of its examinations by the introduction of new subjects and of practical tests. Practical examinations were held this year for the first time in photography, goldsmiths' work, boot and shoe manufacture, and in wood-working in connection with the examination in manual training for teachers of public elementary schools. This last examination is somewhat different in kind from the other examinations of the Institute. It is not a trade examination. Its purpose seems to be to encourage instruction of a distinctly educational character. Moreover, it is a

close examination. None but teachers of public elementary schools are eligible, and these must have regularly attended a course of practical lessons in a registered class under a teacher approved by the Institute. Notwithstanding these restrictions, 615 candidates presented themselves at the first examination held by the Institute, and of these 350 passed, 195 obtaining the Teacher's Certificate.

The report contains full statistics of the results of the examinations in each of the 61 subjects included in the programme, and it also shows the results in each of the 210 towns where the examinations were held. Of the centres outside London, Manchester sent up the largest number of successful candidates, whilst Glasgow, Dundee, and Leeds come next in order. The report calls attention to the fact that the proportion of candidates to the population is far less in London than in Manchester, whilst the hope is expressed that the larger facilities for technical instruction which will be available within the next few years will lead to an increase in the number of students and of candidates for examination. This increase will no doubt take place with the opening of new polytechnic institutions; but we venture to think that the real improvement in technical education cannot be correctly measured by any mere increase in the number of candidates for examination. It depends much more upon the character and quality of the instruction which the candidates receive. The great defect of our present organization is the poverty in knowledge and practical experience of the teachers of our science and technical classes. Some improvement in the qualifications of teachers, and in the conditions of their training, is needed before progress can be measured by the increase in the number of students in attendance, or of candidates for examination.

We notice that in future the Institute proposes to award two kinds of certificates—the one kind to students who have regularly attended a course of instruction under an approved teacher, and the other to candidates who may present themselves for examination without giving any evidence as to their training. In this way the Institute proposes to combine the functions of a teaching and an examining body. The certificate indicating that the candidate has received some training at a school of recognized position will doubtless acquire a distinct value; but much will depend upon the ability and the reputation of the teacher under whom the candidate may have studied.

Of the many alterations in the new programme the most important is the addition of a practical part to the examination in mechanical engineering. This examination of the Institute has never seemed to us wholly satisfactory, as overlapping, to too great an extent, the examinations of the Science and Art Department in applied mechanics, machine construction, and steam. But in future the examination will consist of two parts, one of which will be distinctly specialized with a view to the candidate's occupation. Moreover, in the honours grade, candidates will be required to undergo a practical examination in either machine designing or workshop practice. At the last examination in this subject 966 candidates presented themselves, of whom 536 passed. It is satisfactory to note the continuous increase in the number of candidates in plumbers' work, a trade in the successful practice of which every householder is interested. In this subject a high standard for passing is wisely maintained. Of the 816 candidates who presented themselves, 235 came up for the practical part of the examination, and of these only 85 succeeded in passing in both parts of the examination, and are qualified for certificates.

There is little doubt that the statistics furnished in this report go far to show that a high value is attached by artizans and their employers to the Institute's certificates, and that the progress of technical education has been advanced by the cautious and judicious manner in which the Institute has conducted this department of its operations.

ROBERT GRANT.

IN Robert Grant, who at the ripe age of seventy-eight died at the place of his birth, Grantown-on-Spey, on October 24, 1892, science loses one of her ablest historians. His education was interrupted by a serious illness, which confined him to his bed from his fourteenth to his twentieth year. With surprising energy, however, on his recovery he set about the study of mathematics and the acquisition of ancient and modern languages. After studying for a time at King's College, Aberdeen, he went to London to collect materials for a history of physical astronomy. Thence he proceeded to Paris in 1845, where for two years he attended the lectures of Arago at the Observatory, and those of Leverrier and others at the Sorbonne. Returning to London, he lost little time in beginning the great work with which his name will always be associated. It was published in numbers, the first of which appeared in September, 1848, but it was not until March, 1852, that the whole work was issued. It bears the title "History of Physical Astronomy from the Earliest Ages to the Middle of the Nineteenth Century, comprehending a detailed account of the establishment of the Theory of Gravitation by Newton, and its development by his successors; with an exposition of the progress of research in all the other subjects of Celestial Physics." Most completely do the contents of the volume fulfil every expectation raised by this comprehensive programme. The fame of its author was at once established. Four years later he received from the hands of the late Mr. Manuel J. Johnson, President of the Royal Astronomical Society, the gold medal, then for the first time awarded for literary service to astronomical science. One paragraph of the address delivered on that occasion may here be quoted as characterizing most justly the work as well as its author: "Throughout the book no one can fail to be struck with the rare skill, integrity, and discernment the author has displayed in tracing the successive stages of progress; or with the scrupulous care he has taken to assign to each of the great men whom he reviews their proper share in the common labour. Nowhere is this more conspicuous than in the discussion relative to the discovery of the planet Neptune. By a simple narration of facts he has placed the history of that great event in so clear and so true a light, that I believe I am not wrong in saying he has gained an author's highest praise under such circumstances—the approval of both the eminent persons concerned." Even now, forty years after its publication, the "History" has lost none of its value as a mine of information, and as a delightful guide to those who desire to make a closer acquaintance with the astronomers of the past, as well as their works.

For some time Mr. Grant edited the "Monthly Notices" of the Royal Astronomical Society, and was a member of their Council. In conjunction with the late Admiral Smyth, he translated and edited Arago's "Popular Astronomy" (2 vols. 1855 and 1858). Meanwhile his health had so far improved that in 1858 he was able to go through a course of observational astronomy at Greenwich Observatory. In the following year, on the death of Prof. J. Pringle Nichol, he was appointed Professor of Astronomy, and director of the Observatory in the University of Glasgow.

As a member of the party that went to Spain in the troop-ship *Himalaya*, to observe the total solar eclipse of July 18, 1860, Prof. Grant, from his station near Vittoria, had the satisfaction of seeing a portion of the chromosphere, the existence of which as a thin layer en-

veloping the photosphere he had abundantly demonstrated in the winter of 1850-51, from a discussion of all the observations extant ("History," pp. 395, 396). It can excite no surprise that Prof. Grant assumed the red layer and also the prominences to shine by reflected light, when it is recollected that the sun's light and heat were then supposed to originate wholly in the photosphere while the nucleus was thought to be so cool as possibly to be habitable. When Prof. Grant took charge of the Glasgow Observatory the only useful instrument he found was the transit-circle by Ertel and Son, of Munich, but through the liberality of a few friends, chiefly in Glasgow, a nine-inch Cooke Equatorial was added to the Observatory some years afterwards. After thoroughly testing the transit-circle the new director commenced a series of observations of Mercury, Neptune, the minor planets, and a selection of stars from the British Association Catalogue. Gradually, however, his attention was concentrated entirely on the stars. the list being correspondingly expanded. The observations of planets were communicated from time to time to the *Astronomische Nachrichten* or to the "Monthly Notices."

The stellar observations were published at the expense of her Majesty's Government in 1883 in the well-known "Catalogue of 6415 Stars for the epoch 1870, deduced from Observations made at the Glasgow University Observatory during the years 1860 to 1881, preceded by a Synopsis of the Annual Results of each Star arranged in the order of Right Ascension."

In the introduction will be found a discussion of the Proper Motions of 99 stars. A very complete and appreciative review of this work from the pen of Prof. Auwers of Berlin appeared in the *Vierteljahrsschrift der Astronomischen Gesellschaft* (19 Jahrgang). The Glasgow star places were at once looked on with confidence by the numerous observers of comets and minor planets. One point connected with the Catalogue deserves special mention, viz. that, although the observations from which it is derived extend over a space of twenty-one years, the work appeared within two years of the close of the series. This promptitude excites the greater admiration when we learn that, exclusive of Prof. Grant's personal share in the work, no less than thirteen young assistants at various times took part in the observations, and two others in the computations. Many of these personal changes, each of which brought its quota of extra work to Prof. Grant, were no doubt in some measure due to the smallness of the allowance provided for assistance, viz. £100 per annum Prof. Grant, however, was the last man to waste his energies in useless complaint, and dismisses this point with the remark that "in recent years the work of scrutinizing, reducing to a common epoch, and combining together the vast mass of the observations of the catalogue, extending over a period of more than twenty-one years, has pressed very heavily upon the slender resources of the observatory." The important time service of the City of Glasgow was originated by Prof. Grant some thirty years ago, and continues in operation up to the present moment. In 1855 he received from the University of Aberdeen the degree of M.A., followed by that of the honorary LL.D. in 1865, in which latter year he was elected a Fellow of the Royal Society of London. For three years he presided over the Philosophical Society of Glasgow, to whose proceedings he made various contributions. It may also be noted that among his writings are two remarkable letters proving beyond a shadow of a doubt the spurious character of the pretended Pascal correspondence. These letters were printed in the *Comptes Rendus* by special permission of the French Academy.

In manner Prof. Grant was singularly vivacious, and to the last he greeted with the warmest enthusiasm every fresh discovery in the science to which his life was devoted. R. C.

NOTES.

THE following is the list of names recommended by the President and Council of the Royal Society for election into the Council for the year 1893. The ballot will take place at the anniversary meeting on November 30:—President, The Lord Kelvin, D.C.L., LL.D.; treasurer, Sir John Evans, K.C.B., D.C.L., LL.D.; secretaries, Prof. Michael Foster, The Lord Rayleigh, D.C.L.; foreign secretary, Sir Archibald Geikie, LL.D.; other members of the Council, Captain William de Wiveleslie Abney, C.B., Sir Benjamin Baker, K.C.M.G., LL.D., Prof. Isaac Bayley Balfour, William Thomas Blanford, Prof. George Carey Foster, Richard Tetley Glazebrook, Frederick Ducane Godman, John Hopkinson, Prof. Joseph Norman Lockyer, F.R.A.S., Prof. John Gray McKendrick, William Davidson Niven, William Henry Perkin, LL.D., Rev. Prof. B. Price, The Marquess of Salisbury, K.G., Adam Sedgwick, Prof. William Augustus Tilden.

AN international subscription for a testimonial to M. Pasteur on the occasion of his seventieth birthday on December 27 is to be opened by the French Academy of Science. Many men of science in all parts of the world will be glad to have this opportunity of expressing their high appreciation of M. Pasteur's labours.

SOME time ago we announced that Baron Nordenskiöld proposed to edit a number of very remarkable letters and memoirs of Carl Wilhelm Scheele, who died in 1786. It has now been decided that the one hundred-and-fiftieth anniversary of the birth of this great Swedish chemist, on December 9, shall be made the occasion of a brilliant celebration in his native country. A monument to Scheele is to be unveiled in Stockholm.

THE Naturforschende Gesellschaft of Danzig are issuing invitations to the celebration of the 150th anniversary of their foundation on January 2 and 3, 1893. The meetings will take place on the Monday evening in the Friedrich-Wilhelm-Schützenhaus, and on the Tuesday morning in the large hall of the Landeshaus, and the proceedings will wind up on the latter day with a dinner at 4 p.m. in the Schützenhaus.

PROF. EDWARD PRINCE, of Glasgow, has been offered the important post of Commissioner and General Inspector of Fisheries for Canada by the Dominion Government, and has accepted the office. Prof. Prince is well known as an authority in Fishery Science. He holds the chair of Zoology in St Mungo's College, Glasgow, and is President of the Anderson's College Scientific Society, and Vice-President of the Glasgow Natural History Society.

IT is announced that the King of Italy will open in person the International Medical Congress, which is to be held in Rome next year. An English committee is being formed to do what it can to secure the success of the Congress.

THE New York Academy of Sciences has organized a Biological Section, which is to hold monthly meetings. The opening meeting, at which Prof. H. F. Osborn presided, was held on October 17.

THE Victoria University has issued a list of University Extension lectures which are to be delivered in the course of the session 1892-93. They are to be given at many different centres, and include a wide range of subjects, among which various departments of physical and natural science hold a prominent place.

LIVERPOOL has sustained a real loss by the death of Mr. T. J. Moore, the late curator of the Liverpool Derby Museum. Mr. Moore had a wide knowledge of various branches of science, and did much to foster popular interest in the results of scientific inquiry. He died on October 31.

DURING the latter part of last week the weather continued very unsettled, the depressions which advanced from the Atlantic causing strong southerly winds or gales in many places, with frequent and heavy rain, while the temperature was uniformly high for the time of year, the daily maxima reaching nearly 60° in the southern parts, and exceeding 50° in the northern parts of the kingdom. On Saturday night a considerable decrease of temperature occurred, owing to the advance of an anti-cyclone which subsequently spread over most of the country; the southerly winds gradually disappeared, and were succeeded by calm and variable airs. In the early part of the present week fog became prevalent in many parts of England, but the weather was generally fair with frosts over the inland districts. On Tuesday, however, fresh depressions were passing along our north-west coasts, and rain squalls became general over Ireland and Scotland, while southerly winds again became prevalent. The *Weekly Weather Report*, issued on the 5th instant, showed that the rainfall greatly exceeded the mean in the east and south of England, while in Scotland and the northern parts of England the fall was below the average. Since the beginning of the year, the eastern, Midland, and north-west districts of England have had three inches of rainfall in excess of the normal amount, while in the south-west of England there is a deficiency of 7·6 inches.

THE U.S. Hydrographic Office has issued a chart showing the submarine cables of the world, with their principal land connections. The chart is described by *Goldthwaite's Geographical Magazine* as a necessity to foreign commerce. It contains tables for the computation of rates to any part of the world.

THE November number of the *Kew Bulletin* contains sections on coffee cultivation in British Honduras, the prune industry of California, sugar cane borers in the West Indies, sisal hemp industry in Yucatan, Liberian coffee in the Malay native states, and Bombay aloe fibre. There are also miscellaneous notes, from one of which botanists will be glad to learn that after many unsuccessful attempts to introduce living examples of the interesting plant, *Dischidia rafflesiana*, Kew has at last succeeded, thanks mainly to the generosity of Dr. Treub, the distinguished director of the Botanic Gardens, Java, who sent a plant of it in a Wardian case two years ago. This plant is now established and growing freely, producing numerous large pitcher-like leaves as well as the small normal hoya-like foliage. The morphological meaning of these pitchers has not yet been thoroughly worked out. "The species of dischidia all want a careful study. They cannot be described satisfactorily from dried specimens. The leaves change in form, and it is not ascertained in respect of many species whether they may or may not be converted into pitchers (ascidia)" (Hooker in "Flora of British India"). The plant at Kew is now under the special observation of Dr. Scott, hon. keeper of the Jodrell Laboratory. *D. bengalensis* is an old garden plant. It is cultivated at Kew in the Palm House. *D. rafflesiana* is for the present kept in one of the propagating pits.

AT the opening meeting of the twelfth session of the Junior Engineering Society on November 4, an excellent address was delivered by the president, Dr. John Hopkinson, F.R.S., on the cost of electric supply. His general conclusion on the subject is that to be ready to supply a customer with electricity at any moment he wants it, will cost those giving the supply not much less than £11 per annum for every kilowatt, that is for every unit per hour; and afterwards to give the supply will not cost very much more than ½d. per unit. The clear apprehension of this point Dr. Hopkinson believes to be essential to the commercial success of electric supply. It is hopeless, he thinks, for electricity to compete with gas in this country all along the line, if price is the only consideration. But with selected customers, electricity is cheaper than gas. Surely, he adds, it is the interest of those who supply electricity to secure such customers by charging them a rate having some sort of relation to the cost of supplying them.

AN address delivered by Prof. Virchow at the opening of the recent International Congress of Archæology at Moscow is printed in the current number of the *Revue Scientifique*. Prof. Virchow repeats in this address what he has often said before—that no trace of "the missing link" between man and the lower animals has been discovered either in the human skulls which are believed to be most ancient or in the physical organization of modern savages. He urges that the immediate task for anthropologists is to explain the origin of the existing human races, and to determine the causes by which these races, while retaining the power of hereditary transmission, have acquired their distinctive characteristics. At first sight, he says, it is easy to suppose that a dolichocephalic skull may be transformed into one of brachycephalic form; but it has not yet been shown that any dolichocephalic race has been actually transformed into a brachycephalic one, or *vice versâ*. Prehistoric anthropology ought, he thinks, to find methods which would facilitate the recognition of the types of ancient races and peoples, and enable us to find them again among the races and peoples of the present day. It ought also, as occasion offers, to collect data with regard to those strange individual cases about which theories, as Dr. Virchow holds, have been prematurely formed, and which should be kept in "the scientific baggage" until we have secured intermediate links which will render it possible for us to unite them in a series.

ACCORDING to an official report of Captain von François, the dromedaries which have been introduced into the German territories in South-west Africa in connection with the parcel post service have more than fulfilled the expectations that had been formed about them. The climate suits them, and they are not affected by any of the prevalent cattle diseases. On the road between Lehuititang and Geinab they were six days without water, and on the seventh day, at Geinab, they did not seem to be very thirsty. In stony regions their feet do not, like those of unshod horses or oxen, suffer any injury. When loaded with a weight of 250 pounds, a dromedary advances at much the same rate as an ox-waggon. The only drawback connected with these useful creatures is that they are rather costly.

MR. A. E. DOUGLASS, first assistant at the Boydun station of the Harvard College Observatory, Arequipa, contributes an interesting paper to *Science*, October 21, on indications of a rainy period in Southern Peru. There is evidence to show, he thinks, that for many thousands of years, going back far beyond the recognized period of human habitation, the climate of Peru has been very much as it is at present. That was preceded by a slow rise of the land out of the sea, which caused the climate to change from wet to dry. But under the wet climate the elevation of the land was still too great, and perhaps the duration of the epoch was too short, to produce a luxuriant tropical vegetation; otherwise there would be to-day extensive coal-fields. The wet climate, however, was sufficient greatly to alter the face of the country. Lake Titicaca was of enormous area, fed perhaps by the melting glaciers. In the almost continuous rainy season, huge turbid rivers roared and tumbled down these western slopes of the Cordillera, while on each mountain summit vast quantities of snow fell, only to pursue its way down the steep slopes, carving out valleys, building up ridges, and by its melting wearing out deep ravines, which grow smaller as they become lost in the broad level plain below. Under such luxuriance of moisture the valley of Arequipa must have teemed with animal and vegetable life, the barren hills to the south were clothed in green, and the desert of La Joya blossomed like a garden.

A CAPITAL annotated catalogue of the mammals collected by Dr. W. L. Abbott in the Kilima-Njaro region, East Africa, has been prepared by Mr. F. W. True, and printed in the Proceedings of the fifteenth volume of the U.S. National Museum, with several plates. Dr. Abbott has presented to the National Museum many African collections; but none of them, according to Mr. True, is of more interest than the collection of mammals. The specimens have been prepared with much care, the skins being almost invariably accompanied by the skulls and furnished with labels giving the locality and date of capture, sex, and other data. In determining the species Mr. True has found it necessary to depend almost exclusively on the literature, on account of the lack of specimens for comparison, but the identifications have been made with much care, and may, he thinks, on the whole, be relied upon. Several species apparently new are represented in the collection: *Dendrohyrax validus*, *Mus aquilus*, *Dendromys nigrifrons*, *Sciurus undulatus*, *Cephalophus spadix*. On one who has studied the North American mammalian fauna in detail, Mr. True says, the thought impresses itself that the condition of species, as regards variation, is different in the Ethiopian and Nearctic regions. In North America individual variation seems far less extensive than in Africa, while geographical variation appears to be more extensive and constant. In Dr. Abbott's collection great individual variation is especially apparent in the genera *Galago*, *Genetta*, and *Canis*. It is true that the species of the last-named genus everywhere present much individual variation, but in North America its chief variations appear to be geographical in character. The known range of several species is considerably extended by Dr. Abbott's labours.

AN important contribution to spectroscopy appears in No. 10 of Wiedemann's *Annalen* in the shape of a paper on the infrared emission spectrum of the alkali metals, by Benjamin W. Snow. The method is distinguished by the adoption of a modified form of the bolometer and a very delicate galvanometer with quartz fibre suspension. The fibre, supplied by Prof. Boys, was 40 cm. long. With a scale at a distance of 3m., a deflection of 1mm. corresponded to a current of $1{\cdot}5 \times 10^{-11}$ amp. The spectra were obtained by means of a silicate-flint prism, so as to avoid the overlapping of the infra-red spectra which seems to be inevitable where gratings are used. Since no infra-red lines could be traced in the spectrum produced in the Bunsen or the oxy-hydrogen flame, the electric arc was used, the current being derived from the very uniform Berlin Central supply. The best arrangement for the arc was found to be a hole bored through the centre of the carbon, containing a "wick" of the compressed salt. The bolometer consisted of two platinum-thread resistances. A platinum wire embedded in silver was hammered flat, so as to have a breadth of 0·05mm. and a thickness of 0·00036mm. Two such threads were fastened side by side with shellac on a mica frame. One of them was blackened in a turpentine flame and exposed to the light, the other being covered. The difference of resistance produced by the incident rays was measured by a Wheatstone bridge arrangement, with a shunt contrivance for enlarging the scale of the bridge wire. The resistance of each of the platinum ribbons under ordinary conditions was 75 ohms. The other branches of the bridge were made of German silver wire. The slit of the spectrometer was adjusted to 0·1mm., corresponding to an angle of 1·68 minutes of arc in the spectrum, whilst the breadth of the platinum thread corresponded to an arc of 1'·6. The current through the bridge was maintained at one-fortieth ampere. In the measurement of the intensity of the lines, the energy of radiation was taken as proportional to the first throw. It was found that a standard candle at 1m. distance gave a throw of 150mm. A preliminary investigation of the carbon spectrum revealed a large number of bands reaching up to λ 20620, the principal less refrangible bands being between

7000 and 7700
7850 and 8600
9000 and 10000
10750 and 11600
13700 and 15000

These were made up of innumerable fine lines. It was also observed that the carbon spectrum vanished in comparison with the metallic spectrum as soon as the latter was brought into play. Of the five metals investigated, viz., sodium, potassium, rubidium, lithium, and cæsium, the two rarest were found to be specially rich in infra-red lines. Sodium showed maxima at 8180, 11270, 12400, and 18360, potassium at 7670, 10820, 11580, 12250, and 14610, lithium at 8070, rubidium at 7910, 9980, 13120, and 14760, and cæsium at 8380, a large one at 8820, and others at 9980, 13270, and 14530. Kayser and Runge's empirical law for the alkalies was confirmed for the infrared of lithium and sodium, but not for the other three metals.

MR. ELLIOTT COUES, of the Smithsonian Institution, defends in *Science* the rule, in biological nomenclature, "once a synonym, always a synonym," for the form of which he believes himself to be in some degree responsible. He illustrates the real meaning of the aphorism in the following way. Let there be a genus *Smithia* in botany. Let a genus *Jonesia* then be named. Let *Jonesia* then be found to be the same genus as *Smithia*. Then the name *Jonesia* "lapses into synonomy," and cannot be thereafter applied to any other genus in botany. That is all that is meant by the saying "once a synonym always a synonym." In other words, if *Jonesia* is not good for what it originally meant, it is good for nothing; it is to be deleted absolutely, and cannot come into re-existence by transfer to any other genus. Mr. Coues shows that the same principle holds for all specific names within their respective genera. Example: Let there be a *Rosa Smithi*. Let some one then name a *Rosa Jonesi*. Let *R. Jonesi* be considered to be the same species as *R. Smithi*. Then there can never be a *R. Jonesi*; that is to say, no other species of *Rosa* can be specified as *Jonesi*. But, of course, if any one discovers, after this reduction of *Jonesi* to a synonym of *Smithi*, that what had been called *R. Jonesi* is a good species, then *Jonesi* revives as the name of *that* species; and the fact that it had been (erroneously) regarded as a synonym of *Smithi* is no bar to its use in its original sense.

THE Geological Survey of America has published a paper, by Mr. J. S. Diller, on the Geology of the Taylorville region in the Sierra Nevada, California, immediately north of the fortieth parallel. In this region there are eighteen sedimentary formations and seventeen eruptive masses. The former have a total thickness of 24,500 feet; 17,500 feet are probably Palæozoic, and 7000 feet are Mesozoic. Among the sedimentary rocks, one horizon in the Silurian, two in the Carboniferous, three or more in the Trias, and five in the Jura have been definitely recognized by fossils. Among the eruptives there is great variety. Their extravasation, beginning early in the Palæozoic, recurred vigorously in the Triassic and at the close of the Jurassic, and, finally, also in the Neocene and Pleistocene. The dioritic rocks of the region are a portion of the great granitoid mass of the upper Sierra Nevada, and are evidently eruptive, with well-defined contact phenomena in Triassic formations. Their eruption is certainly post-Triassic, and may have taken place immediately at its close or after the deposition of the Jurassic. There are at least four unconformities in the geologic column of the Taylorville region. During the greater part, if not the whole, of the Palæozoic, the sea covered the region now occupied by the northern portion of the Sierra Nevada. The great disturbance at the close of the Carboniferous may

have been accompanied by an uplift, forming land during the early Triassic; but if so, it subsided and was ready to receive the deposits of the upper Triassic. The disturbance at the close of the Triassic formed no land in the northern Sierra region, but that which closed the Jurassic was accompanied by a great upheaval, excluding the sea to the western base of the Sierras. The general structure of the Taylorville region involves a synclinal and two limiting anticlinals. After the folds were overturned toward the north-east, the Grizzly anticlinal was affected by an overthrust fault in the same direction. The throw along this fault in the older strata is so much greater than in those of Jurassic age as to suggest that a large part of the displacement took place at the close of the Triassic, and was followed by movement on the same plane at the close of the Jurassic.

MR. STANFORD has issued an interesting and valuable contoured map of the county of London. The scale is three inches to a mile. The contour lines or lines of equal altitude are drawn at 25 feet intervals. The lowest contour is 25 feet above the level of the sea, ordnance datum, which is 12 feet 6 inches below Trinity high water. The whole of the alluvial flat lying below the lowest contour, or at a less altitude than 12 feet 6 inches above the river Thames (Trinity high-water mark), is covered by a dark brown tint.

THE third volume of reports upon the fauna of Liverpool Bay and the neighbouring seas has been issued. The reports have been written by members of the Liverpool Marine Biology committee and other naturalists, and edited by Prof. W. A. Herdman, F.R.S.

MESSRS. GURNEY AND JACKSON have published the *Zoological Record* for 1891. It is the twenty-eighth volume of the series. Mr. D. Sharp, F.R.S., has acted as editor, and has had the co-operation of many able zoologists. It is intended that in future the volume shall be published in August or September.

PHOTOGRAPHERS will read with great interest an admirable paper by Captain Abney, in the November number of the *Journal of the Camera Club*, on "shutters," which he describes as "a piece of apparatus which is the very joy and toy of the photographer's existence." The paper is fully illustrated.

THE Rev. L. A. Walker sends to the current number of the *Entomologist* some statistics of the entomology of the Hague, where he acted as chaplain during July. The entomology of Holland seemed to him very disappointing in number of species, and also in individuals in the great majority of cases; less productive, in fact, than the ordinary run of country places at home.

AT the meeting of the Linnean Society of New South Wales on September 28, Mr. R. Etheridge, junior, exhibited seeds of the "Bean-tree," possibly an *Erythrina*, from Macdonald ranges, Central Australia. The seeds are strung and used as necklaces by the aborigines, who use the wood of the same tree for producing fire by friction, and also for shields, on account of its lightness.

A COMPOUND of gold and cadmium of the composition AuCd has been isolated by Messrs. Heycock and Neville, and is described by them in the November number of the Journal of the Chemical Society. During the course of a series of experiments last year upon solutions of gold and cadmium in melted tin, it was observed that the amount of lowering of the freezing-point of the tin by the simultaneous introduction of gold and cadmium was considerably less than the sum of the effects which each of the two latter metals would produce alone. It was surmised that this difference must be due to combination between the gold and the cadmium. Moreover, the product o this combination appeared to be only sparingly soluble in tin, for a considerable quantity of a crystalline precipitate was produced, but owing to the difficulty of freeing it from the tin which solidified over it upon removal, the compound was not obtained in a state of sufficient purity to enable a definite conclusion concerning its composition to be arrived at. Messrs. Heycock and Neville now announce that they have succeeded in preparing the compound in an entirely different manner, and in isolating it in a state of comparative purity. The following is the best mode of procedure:—A piece of the hardest combustion tubing is sealed at one end and slightly bent in the middle so as to form a V-tube of very large angle. A quantity of pure gold is placed in the sealed limb, together with three or four times its equivalent of cadmium. The open end is then drawn off so as to enable the tube to be exhausted by means of the Sprengel pump. As high a vacuum as possible should be obtained, and the tube subsequently sealed. The apparatus is then arranged upon a combustion furnace in such a manner that the excess of cadmium when liquefied may run away from the alloy. When the cadmium first melts it is advisable to vigorously shake the tube so as to diffuse the gold well among the cadmium. The combination then occurs suddenly, accompanied by bright incandescence of the gold. When the larger excess of cadmium has been allowed to run away from the compound, the end of the tube containing the latter is heated for about five hours to a temperature about that of the softening of glass, when the remainder of the excess of cadmium distils regularly off, until towards the expiration of the five hours no further condensation occurs. The product thus left behind was found in three successive experiments to contain about 63·7 per cent. of gold, the percentage required for a compound of the composition AuCd. The compound of gold and cadmium thus obtained presents a silvery greyish-white appearance, is very brittle, and exhibits a crystalline fracture. The action of acids upon it is somewhat singular. Cold acids appear to be without material action upon it, but hot nitric or hydrochloric acid attacks it with great energy, the cadmium passing into solution and the gold being left in the shape of the original ingot.

THE additions to the Zoological Society's Gardens during the past week include a Purple-faced Monkey (*Semnopithecus leucoprymnus*) from Ceylon, presented by Mrs. Elgee; six Short-tailed Voles (*Arvicola agrestis*) from Scotland, presented by Mr. J. E. Harting, F.Z.S.; two Laughing Kingfishers (*Dacelo gigantea*) from Australia, presented by Mr. J. W. Hornsby; a Golden Eagle (*Aquila chrysaëtus*) from Labrador, presented by Mr. J. G. Baxter; a Jackdaw (*Corvus monedula*) British, presented by the Rev. H. W. Reynolds; three —— Geckos (*Gecko verticillatus*) from Burmah, presented by Mr. W. G. Bligh; two American Darters (*Plotus anhinga*). a Common Boa (*Boa constrictor*) from South America, four Bar-tailed Pheasants (*Phasianus reevesi* ♂ ♂ ♀ ♀) from China, purchased.

OUR ASTRONOMICAL COLUMN.

A BRIGHT COMET is announced in Andromeda, seventy seconds preceding Struve 72.

COMET BARNARD (OCTOBER 12).—The following is a continuation of the ephemeris we gave last week of Comet Barnard taken from *Astronomische Nachrichten*, No. 3125.

Ephemeris for 12h. Berlin M.T.

1892.	R.A. h. m. s.	Decl. ° ′	Log *r*.	Log Δ.	Br.
Nov. 11...	20 46 49 ...	+2 33·3			
12...	49 40 ...	2 15·7			
13...	52 32 ...	1 58·3 ...	0·2262 ...	0·1648 ...	0·97
14...	55 25 ...	1 41·2			
15...	20 58 19 ...	1 24·4			
16...	21 1 14 ...	1 7·9			
17...	21 4 9 ...	+0 51·6 ...	0·2250 ...	0·1713 ...	0·94

It may be mentioned that an *Astronomische Nachrichten* circular note contains rather a modified edition of the above places deduced from observations made on October 16, 20, and 25.

Thus for the 13th, the R.A. is given as 20h. 54m. 24s. (app.), and declination (app.) + 1° 54'·5; and for the 17th, R.A. (app.) 21h. 6m. 39s, and declination (app.) + 0° 46'·4.

COMET BROOKS (AUGUST 28).—Owing to the rapid brightening of Comet Brooks, we give the following ephemeris continued from the same source as mentioned last week (*Astronomische Nachrichten*, No. 3125).

12h. Berlin M.T.

1892.	R.A. app. h. m. s.	Decl. app. ° '	Log r.	Log Δ.	Br.
Nov. 11...	9 56 50 ...	+3 18·7			
12...	10 1 8 ...	2 24·6 ...	0·0985 ...	9·9861 ...	15·61
13...	5 29 ...	1 29·6			
14...	9 52 ...	+0 33·8			
15...	14 17 ...	−0 22·9			
16...	18 45 ...	1 20·3 ...	0·0847 ...	9·9712 ..	17·81
17...	23 15 ...	2 18·4			

OCCULTATION OF MARS AND JUPITER BY THE MOON.—Prof. Barnard communicates his observations of the occultation of Mars and Jupiter by the moon, which occurred in one week during last September, to the *Astronomical Journal*, No. 276. The instrument used was the 12-inch equatorial and the seeing was defined as being very fine on both occasions. At the disappearance of the former planet, which took place at the dark limb of the moon, nothing very striking was noticed, the moon's limb at that point being sharp and not dusky, as had been previously seen in an occultation of Jupiter. The times of disappearance and appearance (Mount Hamilton mean time) were:—

	Disappearance. h. m. s.		Reappearance. h. m. s.
1st contact ...	9 9 35·8	...	10 45 56·0 (1s. late?)
Half obscured ...	9 10 4	...	10 26 17
2nd contact ...	9 10 37·1	...	10 26 52·2

In the case of Jupiter, which disappeared at the bright limb, a narrow shadow band was noticed fringing the limb where the planet appeared to cut it. This is due, as Prof. Barnard thinks, to the effect of contrast. The times of contacts were as follows:—

	Disappearance. h. m. s.		Reappearance. h. m. s.
1st contact ...	17 28 10·4	...	18 33 17·5 (2s. late?)
Half obscured ...	17 28 55·0	...	18 33 50
2nd contact ...	17 29 45·7	...	18 34 33·7

MOTION OF THE SOLAR SYSTEM.—The question of the exact position of the point in the heavens to which the sun with his system is travelling has been the object of much research and computation, and the present co-ordinates are now considered as being about R.A. 267° and declination + 31°.

The determination under consideration (*Astronomical Journal*, No. 276) has been undertaken by Prof. J. G. Porter, and is based on the proper motions of 1340 stars, contained in the Publication of the Cincinnati Observatory, No. 12. The method employed for computing the co-ordinates of the apex of the sun's way is that of Prof. Schönfeld; the stars were grouped in four divisions, Division I. including those whose yearly proper motion was less than 0"·30 and contained 576 stars; Division II., motion from 0"·30 to 0"·60, containing 533 stars; Division III., motion from 0"·60 to 1"·20, containing 142 stars; and lastly, Division IV., the motion exceeding 1"·20, 70 stars being included. From these four groups the following values have been deduced, where σ and τ represent the co-ordinates of the apex of the sun's course and $\frac{c}{\rho}$ the velocity of the sun's motion:—

	σ °		τ °		$\frac{c}{\rho}$ "
I. ...	281·9	...	+53·7	...	0·16
II. ...	280·7	...	+40·1	...	0·30
III. ...	285·2	...	+34·0	...	0·55
IV. ...	277·0	...	+34·9	...	0·66

The last determination of these co-ordinates was made, if we are not mistaken, by Prof. Stumpe, and were given in *Astronomische Nachrichten*, Nos. 2999–3000. The values there deduced agree very well with those in question, with the exception of τ in Group I. and σ in Group IV., which consequently throw the mean values rather out. Adopting the same notation, he obtained—

	σ °		τ °		$\frac{c}{\rho}$ "
I. Group ...	287·4	...	+42·0	...	0·140
II. " ...	279·7	...	40·5	...	0·295
III. " ...	287·9	...	32·1	...	0·608
IV. " ...	285·2	...	30·4	...	2·057

Summing up the values obtained by some previous workers, the following table gives the co-ordinates obtained:—

Name.	R.A.	Decl.	No. of stars used in reduction.
Gauss ...	... 259·2 ...	+30·8 ...	—
Argelander	... 259·9 ...	32·5 ...	390
O. Struve	... 261·5 ...	37·6 ...	392
Mädler ...	... 261·6 ...	39·9 ...	2163
Airy ...	... 261·5 ...	24·7 ...	113
Dunkin ...	... 263·7 ...	25·0 ...	1167
Rancken	... 284·6 ...	31·9 ...	106
Birchoff ...	... 285·2 ...	48·5 ...	480
L. Struve	... 273·3 ...	27·3 ...	2509
Stumpe ...	... 285·1 ...	36·2 ..	1054
Porter ...	... 281·2 ...	40·7 ...	1340

SOME REMINISCENCES OF THE MAORIS.

MR. W. COLENSO, F.R.S., has often been asked to record some of his reminiscences of the Maoris, whom he has for very many years had opportunities of studying. This he has now done in a paper printed in the Transactions of the New Zealand Institute (vol. xxiv.), some extracts from which may be of interest for various classes of readers. He says:—

Of the Mako Shark.—Fifty years ago (to go no further back) a Maori chief would be known by wearing certain emblems or insignia indicative of rank, one of which was the tooth of the *mako* as an ear-pendant; and, as such were plentiful, though distributed, the thought often occurred to me in my early travelling days, What a number of the fish *mako* there must have been captured or obtained by the Maoris to yield such a large number of teeth! Moreover, on inquiry I invariably found that all the teeth I saw were prized heirlooms, and had descended to the present possessor through several generations, and (as far as I could learn) none had been recently acquired. And while, when travelling along the sea-coasts for many a league on both sides of the North Island during several years, and always on foot, I had both seen and heard of a number of large sea-animals (fishes and mammals) that were driven on shore on the sandy beaches in severe gales from the sea, I never knew of a single *mako* shark, nor had the Maoris resident on those shores ever heard of one being cast up.

In replying to my numerous inquiries by letter respecting the *mako*, made many years ago, an intelligent aged Maori chief living on the east coast wrote as follows (or, rather, he being of the old school, and unable himself to write, a young adherent did so at his dictation). I give a literal translation of portions of his letter:—

"You ask, did I ever see a *mako* fish? Yes; and it is a very large creature, the biggest of all the sharks (*mango*)—in length 2 fathoms measured (*erua maro whanganga nei*), and in thickness 1 foot. It is a true shark, but called by us a *mako* on account of its teeth. You also inquire concerning its fat or oil, and the edible qualities of its flesh, whether considered choice by us Maoris. Now, there are many kinds of shark, as the *mako*, the *karaerae*, the *pioke*, the *ururoa*, the *uatini*, the *tahapounamu*, the *taiari*, the *tatere*, and the *mangotara*, and I have not eaten of them all, and therefore I do not know how nice or how fat they all are; and so of this one, the *mako*. But, my friend, this fish was never desired as an article of food—never so used by us Maoris. The only part of it that we sought and greatly desired to have was its head, and this solely on account of its teeth. When caught out at the deep-sea fishing-grounds its body was never hauled into the canoe, but the head was cut off while it was still in the sea and alongside of the canoe (*ka tapahia moanatia te upoko*): this done, and the head secured, the body was left to drift away on the sea. The head was also immediately wrapped up securely in a clothing-mat (*kahu*), lest it should be noisily wondered at by those who

were strangers or unacquainted with it (*koi umeretia e nga tangata tauhou*). You also ask what instrument was used for cutting off the head of the *mako*. What, indeed! Why, the saw made of the teeth of the *tatere* shark firmly fixed on to a wooden blade (*he niho tatere, he mea hohou ki runga ki te rakau*). You further inquire respecting the number of its teeth. There are eight—that is, large ones from within—and also eight smaller ones of them outside. Besides those there were several much smaller ones in front or outside (*o waho rawa*), but these I never counted, and therefore cannot give their exact number."

He also wrote (in another and subsequent letter) in answer to my further inquiries: "There are four very large teeth from the beginning, or within. These are called *rei*, and are kept for ear-pendants. Altogether there are eight teeth—that is, four very large ones, and four smaller, making eight in all. The outside teeth resemble those of the *tatere* shark, and are only termed teeth (*niho*); these have no other name, but those that are kept for ear-pendants are called *au rei*. Then, you wish to know how the *mako* was captured by us Maoris in the olden times. Listen. This fish was never taken as other sharks (*mango*) were, with hook and bait: none of our fish-hooks would be strong enough to hold it, they would soon be broken. Now, when the fishing-canoe was out fishing, and had been a long time there catching fishes of various kinds, suddenly a *mako* would be seen coming leisurely along on the surface of the water (*e hara mai noa ana i te kiri o te wai, ara i te kare o te wai*). Then the man who saw it would shout out to his companions in the canoe, 'Haul up our land' (*Hutia mai to tatou whenua*), not naming the fish; and when the *mako* was pretty near to the canoe, about three yards off, then the big tempting bait was let low down before it, and on the *mako* seeing the bait it would bend down its head to seize it (*ka tupou te upoko*), when its tail would be upraised above water. Then a noosed rope would be flung over its tail (lasso-fashion) and quickly hauled tight, which would secure the tail within the noose hard and fast. And away would speed the canoe at a fleet rate towards all sides of the sea and sky, being continually turned about in all directions by the fish, the man who had noosed it always holding on to the rope. At last, being exhausted, the *mako* died; then it floated, when its head would be cut off, as I said before. This was our common manner of catching the *mako* fish (*ko tona hii tonu tenei o tenei ika o te mako*), often also called by us a monster (*taniwha*); and hence arose the term of monster-binding (*heretaniwha*), owing to it being securely noosed and bound with a rope flung over its tail." Here ends the interesting narration of my worthy old Maori correspondent, who died soon after.

I have never seen a *mako* fish, and I am in doubt whether it is yet fully known to science. It is evidently one of the deep-water fishes. The first mention of it by skilled scientific observers that I have noticed is in Sir James Ross's "Voyage to the South Seas," wherein it is stated that on nearing the Chatham Islands, in November, 1841 (within a week after leaving their winter quarters and anchorage in the Bay of Islands), "the long-snouted porpoises were particularly numerous. One of these creatures was struck with a harpoon, and in its formidable jaws we found the teeth which the New-Zealanders value highly as ornaments, and which had puzzled us greatly to ascertain to what animal they belonged" (vol. ii., p. 134). Those Antarctic Expedition ships had spent several months in the Bay of Islands, and the officers had frequent opportunities of seeing and examining the teeth of the *mako*, and very likely had purchased some from the Maoris, as they were diligent in acquiring natural specimens, and curios and ornaments of all kinds.

Professor Hutton, in his "Catalogue of the Fishes of New Zealand" (published by the Government in 1872), considered the *mako* to be the "*Lamna glauca* = tiger-shark;" but he says, "The shark from which the Maoris obtain the teeth with which they decorate their ears is probably this species, but I have seen teeth only" (*l.c.*, p. 77).

Subsequently Professor Julius von Haast (in 1874) read a paper before the Philosophical Institute of Canterbury (Trans. N.Z. Inst., vol. vii., p. 237) on the *mako* of the Maoris, which, he says, is *Lamna cornubica*, the porbeagle shark, and not *L. glauca* as had been supposed by Professor Hutton. But Professor von Haast had only a small young specimen (or, rather, its skin) to examine, which two North Island Maoris, then engaged at Christchurch Museum, pronounced to belong to a young *mako*, and informed him that this fish in its adult state was about 12ft. long. The animal to which the skin belonged was 4ft. 10in. long. Professor von Haast also gives much information relative to the teeth of his small specimen (differing widely from my Maori friend's description given above), their number, form, and size, the colour of its skin, &c. Still, as I take it, there are reasonable doubts as to that specimen being a true *mako*; I think it is highly probable that his two Maori informants had never seen a real *mako* shark.

Couch, in his celebrated work on "British Fishes," in his account of the porbeagle shark, gives a drawing of it from nature, and also others of its teeth and jaws, which appear to be different from those of the *mako*, being much more slender, and semi-terete, undulate, and sharply pointed (vol. i., pp. 41–44).

My object in writing this notice of the *mako* shark is mainly to relate the ancient Maori mode of capturing it.

Of the Preparation of Black Pigment for Tattooing.—The ancient Maoris had more ways than one of obtaining the black substance used in tattooing, which colouring-matter also varied in quality, partly owing to what it was made from; that for the countenance being superior to that used for the lower parts of the body. One way of obtaining the best kind was as follows:—

First, two proper careful men were selected for the work. This, too, was done with ceremony, they being (for the time) *tapu* (*i.e.*, under the laws of *taboo*)—rigidly set apart. A small kiln-like furnace (*ruangarehu*) was excavated in the side of a hill suitably situated. The substances to be used in burning for their soot—*kauri*-resin (*kapia*) and the resinous veins of white pine wood (*kapara*)—were got ready; a net made from the *wharanui* flax leaves finely split, composed of very small and close meshes, and beaten well, so as to be rough and scabrous from long broken fibres, in order the better to catch and retain the soot (*awe*), which was intended to adhere only to the network: this net was fixed properly and securely over the top opening or chimney of the kiln, and above it were placed thick mats and such like, to prevent the escape of the burning soot and smoke. All being ready, a very calm fine night was chosen for the firing of the kiln—a night in which there should not be the least breath of moving air; and, the kiln being fired, those two men remained all night at their post, attending to their work, carefully feeding the fire. When all the resinous substances were burnt up, and the kiln cold—the calm weather still continuing—the soot was carefully collected and mixed up with the fat of birds, and then given to a Maori dog to eat, which dog had also been early set apart for this work—tied up, made to fast, and kept hungry, that it might perform its part and eat the prepared morsels with avidity. After devouring the mixed food the dog was still kept tied up, and not allowed to eat any other aliment until it had voided the former. When the fæces were evacuated they were carefully gathered, and mixed up and kneaded with bird's oil and a little water, and, when this mixture became dry and hard, it was put up securely into a large shell, or into a hollowed pumice or soft stone, and laid by carefully, buried in the earth, for future use. It is said to have possessed no disagreeable odour when dry (though it had while fresh), and, though long kept, it did not become bad nor spoil through keeping, which, on the contrary, was said to improve it, and it was very much prized.

It was this pigment, so put up and kept, that was the origin of one of their proverbs, "*Puritia to ngarahu kauri*" = Keep to thyself thy kauri-resin-soot pigment. This saying was used when a person was unwilling to give what was asked, the same being some common thing, and not at all needed by the avaricious owner. But there is a double meaning here in this simple sentence (proverb)—namely, "You may never require it, or live to use it." (See Trans. N.Z. Inst., vol. xii., p. 145.)

Of the Manufacture of their Long Spears.—Some of their spears were very long. Of these there were two kinds. One kind was made of hardwood, *rimu* (*Dacrydium cupressinum*). This was used in defending their forts and stockades before the introduction of firearms, being thrust through the palisades at close quarters against the legs and bodies of the invaders. The other kind was much lighter, though longer, being made of the light wood of the *tawa*-tree (*Beilschmiedia tawa*), and used only for the spearing of pigeons when they were sitting on the top of a high tree. This spear was tipped with a flattish serrated bone 3 inches—5 inches long, usually coarsely barbed on one lateral edge, and sharply pointed; the bone being human, and a portion of that of the arm or leg, and, of course, of their

deadly enemies. Seeing that these long spears were always made from heartwood of their tallest trees, it was a mystery to me how they managed to manufacture them, the hardwood ones being from 16 feet to 20 feet and the others from 20 feet to 35 feet long; and it was not until my first visit to the Urewera Tribe, at Ruatahuna, in the interior beyond Waikare Moana, in 1841, that I discovered how it was effected. This patient performance has ever seemed to me a notable example of one of their many laborious and persevering works. For it must never be forgotten, in considering their ancient laborious and heavy works, especially in hard substances, as wood, bone, and stone, that they accomplished all without the use or knowledge of iron or any other metal.

First, a straight, tall, and sound *tawa*-tree was selected in the forest. This was felled with their stone axes. Its head and branches having been lopped off, it was dragged out into the open ground, and split down the middle into two halves. If it split easily and straight, then it would probably serve for two spears, if each half turned out well in the working. The next thing was to prepare a long raised bed of hard tramped and beaten clay, 35ft.-40ft. long—longer than the intended spear—the surface to be made quite regular and smooth (like a good asphalte kerb town walk of the present day). On to this clay bed the half of the *tawa*-tree was dragged, and carefully adzed down by degrees, and at various times, to the required size and thickness of the spear. It was not constantly worked, but it was continually being turned and fixed by pegs in the ground, to keep it lest it should warp and so become crooked. It took a considerable time—about two years—to finish a spear. The last operation was that of scraping with a broken shell or fragment of obsidian, and rubbing smooth with pumice-stone. When quite finished and ready for use a suitable tall and straight tree was found in, or on the edge of, the forest; its trunk was trimmed of branchlets, &c.; the long spear was loosely fixed vertically to it, so as to run easily through small round horizontal loops girt to the tree, and placed at some distance from each other; the tip of the spear concealed, yet protruding near the topmost branches of the tree; and, as the pigeon is a very thirsty bird (especially, I should think, after feeding on the large fruits of the *tawa* and of the *miro—Podocarpus ferruginea*—trees, which are hot and piquant), the Maoris made small corrugated vessels of the green bark of the *totara* tree that would hold water, and fixed such on the top of the tree to which the long spear had been lashed, and by-and-by, when the bird was settled above after drinking (for it is a very quiet bird, sitting long after feeding), the spear was gently pulled down by its owner below on the ground, and sent up with a jerk into the body of the pigeon. I have seen the fixed spear thus used in the forests, and have eaten the bird so captured.

I may here mention that I have also seen those totara-bark dishes, with water in them, fixed high up on the big branches of trees in the woods in the Urewera country, having flax nooses so set over the water as to catch and hold fast the pigeon in its drinking. I have seen pigeons so caught, the Maoris climbing the trees naked with the agility of monkeys to secure their prizes.

From the large amount of labour and the time consumed in the making of a long spear, and its great beneficial use when made, arose a good proverb among them relative to industry in tillage, &c., and to being prepared—"*Kahore he tarainga tahere i te ara*" = You cannot hew a bird-spear by the way. Meaning: Without timely preparation you may die from want of food, though the pigeons are plentiful in the forests near you.

Of the Fine Smelling-sense and Taste of the Ancient Maoris for Perfumes.—I have already more than once, and in former papers read here before the Institute, touched on the superior powers of sight of the ancient Maoris;[1] and it has often occurred to my mind that they also possessed a very keenly developed sense of smell, which was largely and quickly shown whenever anything sweetly odoriferous, however fine and subtle, had been used—as eau de Cologne, essence of lavender, &c. Indeed, this sense was the more clearly exhibited in the use of their own native perfumes, all highly odorous and collected with labour. Yet this sensitive organization always appeared to be the more strange when the horribly stinking smells of two of their common articles of food—often, in the olden times, in daily use—are considered: rotten corn (maize, dry and hard, in the cob) long steeped in water to soften it; and dried shark. The former,

[1] Trans. N. Z. Inst. vol. xiv. p. 67, &c.

however, has long been abandoned; yet at one period every village at the North had its steeping-pit.

In a paper I read here at our June meeting I mentioned some of the very small Hepaticæ (*Lophocolea* and *Chiloscyphus* species) as being used for perfume by the Maoris, who called them *piripiri*. Their scent was pleasant, powerful, and lasting. Hooker, in describing those plants, has mentioned it from dried and old specimens. Of one species, *Lophocolea pallida*, he says, "odour sweet;" of another, *L. novæzealandiæ*, "often fragrant;" of another, *L. allodonta*, "odour strong, aromatic;" of another, *Chiloscyphus fissistipus*, "a handsome strongly-scented species:" and he has further preserved it to one of them in its specific name, *C. piperitus*, "odour of black pepper."

There were also two or three ferns—viz., *Hymenophyllum sanguinolentum*, a very strong-smelling species, hence too its specific name; dried specimens not only retain their powerful odour, but impart it to the drying papers: *Polypodium pustulatum*, having an agreeable delicate scent: and *Doodia fragrans*, a neat little species; this last was so far esteemed as sometimes to give name to the locality where it grew, as *Puke mokimoki*,[1] the little isolated hill which once stood where the Recreation-ground now is in Napier; that hill having been levelled to fill in the deep middle swamp in Monroe Street.

One of the *Pittosporum* trees, *tawhiri* (*P. tenuifolium*), also yielded a fragrant gum; but the choicest and the rarest was obtained from the peculiar plant *taramea* (*Aciphylla colensoi*), which inhabits the alpine zone, and which I have only met with near the summits of the Ruahine Mountain-range, where it is very common and very troublesome to the traveller that way. The gum of this plant was only collected through much labour, toil, and difficulty, accompanied, too, with certain ceremonial (*taboo*) observances. An old *tohunga* (skilled man, and priest) once informed me that the *taramea* gum could only be got by very young women—virgins; and by them only after certain prayers, charms, &c., duly said by the *tohunga*.

There is a sweet little nursery song of endearment, expressive of much love, containing the names of all four of their perfumes, which I have not unfrequently heard affectionately and soothingly sung by a Maori mother to her child while nursing and fondling it:—

Taku hei piripiri,
Taku hei mokimoki,
Taku hei tawhiri,
Taku kati-taramea.

My little neck-satchel of sweet-scented moss,
My little neck-satchel of fragrant fern,
My little neck-satchel of odoriferous gum,
My sweet-smelling neck-locket of sharp-pointed *taramea*.[2]

Here I may observe that to the last one of the four the word *kati* is prefixed: this word—meaning, to sting, to bite, to puncture, to wound sharply and painfully—is added to indicate the excessive sharpness of the numerous leaves and leaflets of the *taramea* plant (hence judiciously generically named by its early discoverer, Forster, *Aciphylla* = needle-pointed leaf), and the consequent pains, with loss of blood, attending the collecting of its prized gum, thus enhancing its value.

This natural and agreeable little stanza, one of the olden time, has proved so generally taking to the Maori people that it has passed into a proverbial saying, and is often used, hummed, to express delight and satisfaction—pleasurable feelings. And sometimes, when it has been so quietly and privately sung in a low voice, I have known a whole company of grey-headed Maoris, men and women, to join in the singing: to me, such was always indicative of an affectionate and simple heart. How true it is, "One touch of nature makes the whole world kin"![3]

In the summer season the sleeping-houses of their chiefs were often strewed with the large sweet-scented flowering grass *karetu* (*Hierochloe redolens*). Its odour when fresh, confined in a small house, was always to me too powerful.[4]

[1] Mokimoki Hill, from *mokimoki*, the name of that fern.

[2] See Trans. N.Z. Inst., vol. xii., p. 148.

[3] It is pleasing to notice that the observant artist Parkinson (who was with Sir Joseph Banks as his botanical draughtsman, and Cook on his *first* voyage to New Zealand) makes special mention of those little satchels in his Journal, saying of these Maoris who came off to the ship in their canoes, "The principals among them had their hair tied up on the crown of their heads with some feathers, and a little bundle of perfume hung about their necks" (Journal, p. 93). Captain Cook, also, has similar remarks respecting the young women.

[4] Sir J. D. Hooker thus writes of this fine, sweet-smelling grass in his "Flora Novæ Zelandiæ": "A large and handsome grass, conspicuous for its delicious odour, like that of the common vernal grass (*Anthoxanthum*) of England, that gives the sweet scent to new-made hay" (*l.c.*, vol. ii., p. 300). A closely-allied northern species (*H. borealis*), which was also supposed to

Here, in conclusion, I may briefly mention an instance of their correct discrimination on the contrary side, clearly showing how well and closely the ancient New-Zealander agreed in his opinion of a plant with the highly civilized scientific visitor already named above, the botanist Forster. Forster named the *Coprosma* genus from the fetid odour of the first species he discovered in the South Island, which signification he also continued in its specific name, *C. fœtidissima:* this shrub also bears a similar Maori name, *hupiro*, highly expressive of its very disagreeable smell.

Of their Textile Manufactures.—These were formerly prominent among the great industrial achievements of the Maoris, and always elicited the admiration of their wondering visitors.

I divide them into two great classes—(1) of garments, which were woven; and (2) of threads, cords, lines, and ropes, which were spun.

Nature had given to the Maoris one of her choicest gifts in the well-known flax plant (*Phormium*), of which there are two ascertained and valid species (*P. tenax* and *P. colensoi*), and several varieties. These plants are pretty general throughout New Zealand, and are well known to the Maoris by the common names of *harakeke*, *wharanui*, *wharariki*, and *tihore*—excluding those of the many varieties as known to them.[1] So that what they may have lost on the one hand through not having the valuable wild edible fruits of other South Sea islands (as the cocoanut, bread-fruit, plantain, &c.) they more than merely gained in their flax plant, which is also common, and almost endemic, being only found outside New Zealand in Norfolk Island.

And here I may briefly mention an anecdote of the flax plant. On my arrival in this country the Maoris (who knew nothing, or very little, of any other land) would often inquire after the vegetable productions of England; and nothing astonished them more than to be told there was no *harakeke* growing there. On more than one occasion I have heard chiefs say, "How is it possible to live there without it?" also, "I would not dwell in such a land as that." This serves to show how highly they valued it. Moreover, at first and for many years the principal export from New Zealand prepared by the Maoris was the fibre of this plant—all, too, scraped with a broken shell, leaf by leaf.

1. *Of their Woven Articles* (*or Garments*).—I do not intend to say much of them in this paper. Many of them are well known, and still to be found in use among the Maoris, but their manufacture has for many years sadly deteriorated: indeed, I have not seen a newly-made first-quality clothing-mat for the last twenty to thirty years, and I very much doubt if such can now be made at all. Not that the art of weaving them has been entirely lost, but the requisite taste, skill, and patience in seeking and carefully preparing and using the several parts (including their dyes) are no longer to be found among the Maoris. I sometimes indulge in a contemplating reminiscence—an idea—a pleasing reverie of the long past—of great gatherings of Maoris, tribes and chiefs; and at such times the figures of some head men I have known, clothed in their handsome, clean, and lustrous dress-mats (*kaitaka* and *aronui*), would stand forth in pleasing high relief. The close and regular weaving of such flax dresses, having their silky threads carefully selected as to fineness and uniformity of colour, and their smooth, almost satiny appearance, as if ironed or calendered when worn new, was to me a matter of great satisfaction—a thing to be remembered—"a joy for ever."

Those best dress-mats were always highly prized, both by Maoris and Europeans, and brought a high price. I well recollect a young lady, daughter of very respectable early English settlers in the Bay of Islands, who, when she came across the inner harbour in a boat with her parents to attend the English Church service on Sunday mornings in the Mission chapel at Paihia, often wore one of them folded as a shawl, and to me it seemed a neat and graceful article of dress.

Three things more in connection with these fine mats I will just relate: one, the cross-threads in weaving were always of a different sort of flax—the weft and the woof of these mats were not both taken from the same kind of flax; the second, that extremely soft lustrous appearance was given to the flax-fibres by repeated tawing done at different times—it was a pretty sight to see the various skeins of flax-fibres in their several stages of preparation neatly hung up in the weaving-shed; the third, that in the weaving of one of these garments, if a thread showed itself of a different shade of colour, that part of the garment was carefully unravelled to take it out, and to substitute another better suited in its stead. It was also from this superior knowledge and close attention to their work that the principal chiefs frequently took women who were clever at making those things to be their wives, in order to secure to themselves their valued manufactures.

They also wove very good and useful floor and bed-mats of unscraped flax-leaves, split into narrow lengths and carefully bleached in the sun—these were very strong and lasting; also baskets and kits of all sizes. Some of them were woven in regular patterns with black (dyed) and uncoloured flax; others were skilfully and pleasingly semi-damasked (if I may so term it) by changing sides to the flax-leaves used to form the pattern, the upper side of the leaf being smooth and shining, the under side not shining and of a glaucous colour. The little kit, or basket, for a first-born child was often a little gem of weaving art, and made by the mother.

Besides the flax plant they had other fibrous plants whose leaves and fibres were also used in making articles of dress: (1) the *toii* (*Cordyline indivisa*), of which they made black everlasting wraps or cloaks. The making of these was confined to the natives of the mountainous interior, where alone those plants grow. (2) The long orange-coloured leaves of the *pingao* (*Desmoschœnus spiralis*), a prostrate spreading sea-side plant, also afforded them good materials for weaving useful folded belts, which were strong and looked and wore well, and were highly valued. (3) The climbing *kiekie* (*Freycinetia banksii*) was also used; likewise the long, slender, and soft leaves of the *kahakaha* (*Astelia banksii*), but not frequently. (4) Of the leaves of the common swamp plant *raupo* = bulrush (*Typha angustifolia*), they formed large sails for their canoes. These leaves the Maoris curiously laced together. (5) I should not omit to mention their flying kites (*pakaukau* and *manuaute*), formerly in great esteem among them, and made of the manufactured bark of the *aute* shrub = paper mulberry (*Broussonetia papyrifera*), which was formerly cultivated by the ancient Maoris for its bark. Inferior ones, however, were made of the prepared leaves of some of the larger sedges. They were prettily made, requiring both time and skill in their construction, and much more resembled a bird flying than our English ones. They always served to remind me of those of the Chinese, as we see them in their own drawings and on their chinaware. The old chiefs would sometimes quietly spend hours amusing themselves in flying them and singing (*sotto voce*) the kite's song, using a very long string.[1] Kites being flown at any village or fort was a sure sign of peace. These, too, gave rise to proverbs, some being quaint and highly expressive. A pleasing one I give as a sample: "*He manuaute e taea te whakahoro*" = A flying kite made of paper-mulberry bark can be made to fly fast (away, by lengthening the cord). Used by a lover, expressive of impatience at not being able to get away to see the beloved one.

2. *Of their Spun Fibrous Articles.*—These were very numerous in kind, size, and quality, according to the particular use for which they were required; and, while the larger number of them were composed of scraped and prepared flax-fibres there were also other fibrous-leaved plants used by the Maoris, particularly the leaves of the erect cabbage-tree = *tii* (*Cordyline australis*) and of the *kiekie*, already mentioned. Here, too, in this department, the different kinds of varieties of the flax would be used for making the different sorts of threads, cords, and ropes, some of the varieties of flax enduring much greater strain when scraped and spun into lines than others; and of such their deep-sea fishing-lines were made. It was ever to me an interesting sight to see an old chief diligently spinning such lines and cords—always done by hand, and on his bare thigh. The dexterity and rapidity with which he produced his long hanks and coils of twine and cord, keeping them regular, too, as to thickness, was truly wonderful. Some of their smallest twisted cords or threads were very fine. Such were used for binding on the barbs to their fishing-hooks, and for binding the long queues of

be found here in New Zealand, is also used on the Continent of Europe for similar purposes. In some parts of Germany it is dedicated to the Virgin Mary (hence, too, its generic name of *Hierochloe* = sacred grass), and is strewed before the doors of the churches on festival days, as the *sweet sedge* (*Acorus calamus*) is strewed on the floor of the cathedral at Norwich for the same purpose at such seasons.

[1] Sir James Hector, in his book on the *Phormium* plants, enumerates fifty-five named varieties; but it is doubtful whether more than half of that number are permanent ones.

[1] See an interesting historical tradition respecting such (Trans. N.Z. Inst., vol. xiii., p. 48).

dog's hair to their chiefs' staffs. One of those peculiar cords was a very remarkable one; it was a small cord, bound closely round throughout its whole length with a much smaller one (something like the silver or fourth string of a violin). I never saw this kind but once, and that was at the East Cape, in 1838. A specimen of it I shall now exhibit. This cord was used for a single and particular purpose, attached to the small under-aprons of girls—chiefs' daughters.

Their larger cords and ropes were composed of several strands, well twisted and put together. Besides their round ropes so made, they had also flat ones of various widths, which were plaited or woven, resembling our webs and bands, and much used as shoulder-straps in carrying back-loads; also double-twisted ropes, and three-strand ones; likewise a remarkably strong one that was four-sided. This was made of the unscraped leaves of the cabbage-tree, that had been gathered, and carefully wilted in the shade, and then soaked in water to make them pliant. It was used for their anchors, and other heavy canoe and house requirements. The leaves of the flax would not be suitable for this purpose. I have had all those different kinds of cords and ropes made for me in former years, but I much fear the art of making them is lost.

There were also their nets for catching fish and for other purposes, with their meshes of various dimensions. Their smaller ones (hand-nets) were made of all manner of shapes and sizes. Some of them were dexterously stretched over circular skeleton framework. And their large seine-nets, used for catching mackerel and other summer fish that swam in shoals, were very long and very strong, made of the leaves of flax, split and prepared, but not scraped, and completely fitted up with floats, and sinkers, and ropes, and other needful appurtenances. Cook, who was astonished at their length, has written much in praise of them. I make one striking quotation: "When we showed the natives our seine, which is such as the King's ships are generally furnished with, they laughed at it, and in triumph produced their own, which was indeed of an enormous size, and made of a kind of grass [*Phormium*] which is very strong. It was five fathoms deep, and by the room it took up could not be less than three or four hundred fathoms long."[1] (Voyages, vol. ii., first voyage, pp. 369, 370.)

In residing at Dannevirke, in the Forty-mile Bush district, during several months, I have often noticed the Maoris from neighbouring villages coming to the stores there to purchase tether and other ropes and lines (large and small) for their use with their horses, ploughs, carts, pigs, &c., while on their own lands and close to them the flax plants grew in abundance. These Maoris had very little to occupy their time, and could easily have made common lines and ropes for their own use if they knew how to spin them as their fathers did, and also possessed their forefathers' love of work.

UGANDA.

At a special meeting of the Royal Geographical Society on the evening of November 3, Captain F. D. Lugard gave an account of the geographical aspects of his work in Uganda. The hall of the University of London was crowded, and although the issue of extra tickets was suspended, a large number of Fellows and their friends failed to get admittance. An excellent hand-map, by Mr. Ravenstein, enabled the audience to follow Captain Lugard's route. The first part of the paper was concerned with the journey from Mombasa along the Sabakhi river, an unnavigable stream, to Machako, the furthest station of the I. B. E. A. Company at that time, the district passed through being almost uninhabited, and supplies difficult to procure. The greater part of the paper related to Uganda and the other countries surrounding he Victoria Nyanza, where Captain Lugard was in command for two years. On the Kavirondo plateau, east of the lake, there is a promising field for European colonization. The plateau is crossed by the Equator, but at elevations of from 7000 to 8000 feet the climate is cool and exhilarating. It is possible, judging from experience in other places, that highlands close to the Equator are healthier for Europeans than those of similar mean climate lying nearer the tropics. Kavirondo is admirably adapted for grazing, and ranches similar to those of the west of America might be tried. From the pasture lands of this plateau the transition to the rich plantations of bananas and casava of Usoga and Uganda is very marked, and the unclothed natives of Kavirondo give place to the comfortably-dressed Waganda, a warlike people, but skilful in all the arts of peace.

Uganda is a land of low hills and valleys. The hills are of red marl, or marl-gravel, and shale, generally covered with pasture grass of a kind apparently peculiar to these countries. The valleys are generally of rich black soil, and most frequently the lowest part of the dip is a river swamp. The swamp varies from a few score of yards to a mile or more in breadth, usually being from half to three-quarters of a mile. There is a slight trickling current—but very slight; the river is choked with dense papyrus, with an undergrowth of marsh ferns, grass, reeds, &c. The water is usually the colour of coffee, and red with iron rust. Most of these swamps are of treacherous quagmire without bottom; and unless the roots of the papyrus form a sufficient foothold it is necessary to cut down reeds and boughs of trees to effect a crossing. It is a singular characteristic of these countries that, spite of their altitude and hilly character, rushing water is rarely, almost never, to be seen. Thus Uganda has a mean elevation of some 4200 feet, and borders the trough of the Victoria Nyanza at 3700 feet only, and is a country full of hills and valleys. Kitagwenda, at about the same altitude, borders the Albert Edward Lake at 3300 feet. Unyoro, with more lofty hills and peaks of granite, with an altitude gradually increasing in the south, as you near the Albert Lake, to some 5300 feet, similarly borders the trough of the Albert, which has an elevation of only 2000 feet. Yet nowhere are these river swamps more frequent than here in South Unyoro at the highest altitudes. The origin of the water to supply the enormous Lake Victoria is an interesting problem. Throughout the British sphere, on the north and west of the lake, there is no single river, except the Nzoia, which is worthy of the name flowing into the Victoria. The Katonga—marked on the maps as a big river—is merely a broad papyrus swamp. It is by no means so important a drainage as the Marengo; and all the endless river-swamps (including the Marengo) send their sluggish streams northwards to the Kafur and the Somerset Nile. The superficial area of the Victoria being 27,000 square miles, crossed by the Equator, and at an altitude of about 3800 feet, an enormous amount of evaporation must occur, and yet spite of this evaporation, there issues from its north-western corner the magnificent Somerset Nile, a deep, broad, silent river.

The close of the year 1891 and the early part of 1892 were exceptional in the matter of rainfall. Usually in this part of Africa the lesser rains begin early in October and cease in the middle of December. From that time the heat and drought increase, and the grass dries up and is burnt, till in the beginning of March the greater rains set in, and a tropical downpour continues with few breaks till the end of May. Last October and November the lesser rains were unusually heavy, and continued with little intermission till the time of the regular rains in March. There was a little check, and then the rain continued up to the middle of June and later. The result was, that the Lake Victoria was some six feet perhaps above its ordinary level, and may probably rise still higher. Unusual floods occurred in the Nile in Egypt during September, this not being the time at which the usual high Nile due to the Atbara floods occurs.

Uganda is divided into ten provinces, and the ten chiefs who rule these districts entirely drop their personal names, and are called by the traditional title attached to those provinces. Of these the four largest and most important have separate titles. Thus, the chief of Chagwe is the Sekibobo; of Singo, the Mukwenda; of Buddu, the Pokino; and of Bulamwezi, the Kangao. The remaining six are called by the title of their province, viz. Kitunzi, Katambala, Kasuju, Mugema, Kago, and Kaima. Superior in rank to these ten governors of provinces are the Katikiro (the vizier and chief magistrate of Uganda), and the Kimbugwe. These two hold innumerable estates, scattered throughout the country.

In June, 1891, Captain Lugard left Uganda with the object of coming in touch with the Soudanese refugees from the Equatorial Province, who had assembled at Kavalli's, on the south-

[1] An interesting historical tragic story of the cleverly-planned taking and death of a large number of Maoris in one of these seine-nets, together with the fish (illustrating what Cook has written of their immense size), and of the deadly warfare that followed, is given in the Transactions N.Z. Institute vol. xiii., p. 43.

west shore of the Albert Lake. Marching from near Masaka, the capital of Buddu, he traversed Northern Ankole, a district hitherto unvisited by any European, though Mr. Stanley, in 1876, had travelled parallel to it within the boundaries of Uganda, and reaching the borders of Kitagwenda, proceeded south-west to the narrow channel or river which connects the upper lake of Rusango with the main waters of the Albert Edward Lake. Crossing this narrow channel (at most 500 yards wide) the force camped in the hostile country of the Wasura, a tribe subject to Kabarega of Unyoro, and identified with the Wanyora. Here they crossed Mr. Stanley's route at the Salt Lake; but since his book nor maps had not then reached Central Africa the journey was in the nature of entirely new exploration, though of course the discovery of the Albert Edward Lake and of Ruwenzori had been anticipated. The natives, too, being hostile, no one was met with who had seen Mr. Stanley, or could give information of his route, or tell of his exploits. On the route to the Albert Lake many deep and almost symmetrically circular depressions like the crater of a volcano, or a dried-up pond, were passed. A few of these, as shown on the map, were tiny lakes no bigger than a mill-pond, but apparently of great depth, with clear blue water, and all the characteristics of a lake. The alligator and great fish eagle haunted their waters. Others, again, were dry, the bottoms being perhaps 100 feet or more below the level of the surrounding country, which is about 4200 feet above the sea.

The Lake Albert Edward consists of two portions, the Mwutan-zigé (Barrier to Locusts), or the Great Lake and the Rusango on the north-east. This latter is in reality a separate lake, connected with Mwutan-zigé by a river. Its general direction is north-west and south-east. There is no swamp around it except at the north-west end, where dense jungle and impenetrable marsh afford a home for great herds of elephant. It is at this point that the rivers Wami and Mpanga, into which the countless streams from Ruwenzori flow, bring their waters to the lake. The gorge through which the latter flows is picturesque in the extreme, especially in the rains. The great body of water confined between its rocky walls boils and eddies over the sunken rocks below. The gorge is some 700 feet deep, and is full of tropical forest. The orchids, ferns, and mosses which are found in such a natural forcing-house, where the damp vapours hang, are extremely luxuriant.

Captain Lugard followed the eastern base of the Ruwenzori Mountain, crossing the endless streams which descend from its perpetual snows, and bear their clear, sparkling, icy-cold water to the Wami and Mpanga, and so to the Albert Edward. The drainage of the eastern Ruwenzori is not towards the Albert and so to the Nile, but to the southern lake, from which the only overflow is the Semliki, a river which at its exit probably conveys a lesser volume of water from the Lake than is contributed to it by the Mpanga alone. The ground rises gradually from the level of the Albert Edward 3300 feet to some 5300 feet at Kiaya. Here the route descends into the head of a narrow valley, while the plateau trends away to the right, and forms the uplands of Unyoro, its bold outline appearing from the Semliki Valley and the Albert Lake like a lofty range of hills. The valley of Kiaya is extremely fertile, intersected with streams, and studded with banana groves and cultivated land. Between the edge of the plateau on the east and the base of Ruwenzori there is a deep trough, or gorge, the hills rising steep as it were from their own foundations without connection with the plateau, which reaches to their very feet. Leaving Kiaya, they passed through a wild country of quartz and scrub jungle, cut at right-angles by gigantic ravines of rich soil, in which are villages, forest, and cultivation. This led to the edge of a lower plateau, overlooking the Semliki valley. Simultaneously the massive peaks of Ruwenzori sloped down to lesser hills, and mingled with the plain, and a new range of mountains, increasing in height from south to north, appeared opposite. Mountains they appear, but, like those left behind, they are really the escarpment of the plateaus on which the sources of the Ituri, and the other great affluents of the Congo, take their rise; which, for convenience, may be called the Kavalli plateau. From Kavalli's Captain Lugard escorted 8000 Soudanese troops, who had by their vacillation retarded the departure of Stanley with Emin for the coast. Some of these he settled in forts to protect Uganda from Kabrega's raiders, while others were sent back to Egypt by Mombasa.

SCIENTIFIC SERIALS.

American Meteorological Journal, October.—A meteorological balloon ascent at Berlin by A. L. Rotch. The ascent was made on the morning of October 24, 1891, and at the same time a captive balloon was sent up to 600 metres. The weather was hazy up to about 1000 feet, but above that the sky was nearly clear. The mean decrease of temperature between the ground and the captive balloon was 0°6 C. per 100 metres. In the stratum of air between the captive and free balloon (700 to 1000 metres) the decrease was much slower during the morning, there being at first an increase, the temperature at 693 metres was 10° C., and at 858 metres 10°·4. In the afternoon the rate of decrease in the upper stratum became nearly the same as that which prevailed in the lower stratum during the morning.—Improvement of weather forecasts, by Prof. H. A. Hazen. The author recommends the study of moisture conditions at various heights in the atmosphere, and considers that the greatest hope of improvement is in the observation of atmospheric electricity.—The storms of India, by S. M. Ballou. The storms are divided into three classes: (1) the cyclones that occur at the changes of the monsoons; (2) the storms of the summer rains; (3) the winter rains of the northern provinces; he discusses the causes of their formation, and gives a brief description of each of these classes.—The ether and its relation to the aurora, by E. A. Beals. The author gives a brief summary of some of the facts respecting our knowledge of auroras, in view of their probable maximum during the coming year in connection with their correlation with frequency of sunspots.—There are also short articles on warm and cold seasons, by H. Gawthrop; facts about rain-making, by G. E. Curtis; and convectional whirls, by Prof. H. A. Hazen.

SOCIETIES AND ACADEMIES.

London.

Anthropological Institute, October 18.—A special meeting was held, the president, Edward B. Tylor, D.C.L., F.R.S., in the chair, to receive a communication from Major R. C. Temple, I.S.C., on "Developments in Buddhist Architecture and Symbolism as illustrated by the Author's Recent Exploration of Caves in Burma." Major Temple commenced by saying that the object of the paper was chiefly to draw attention to the extraordinarily rich and for the present practically untouched field for the ethnographist and antiquary existing in Burma. He exhibited some photographs of life-size figures in wood, carved by a well-known artist of Maulmain, of the "four sights" shown to Buddha as Prince Siddhartha on his first visits to the outer world, viz., the old man, the sick man, the dead man, and the priest; and also some admirable gilt wooden representations from Rangoon of Buddha in his standing and recumbent postures, with his begging bowl, and seated as King Jambupati, surrounded by priests and other worshippers. He next showed a remarkable set of gilt wooden images from the platform of the great Shwedagon pagoda at Rangoon, of *nats*, *belus*, *hanuman myauks*, and other spirits believed in by the Burmese, seated on the steps of a lofty *tagon-dain*, or post, on the top of which is always perched the figure of the hentha (hansu), or sacred goose, which apparently protects pagodas in some way. From these he passed on to four representations of large glazed bricks or tiles from Pegu. These curious, and (so far as English museums are concerned) probably unique antiquities may be presumed to be at least 400 years old, and formed at one time the ornamentation of the three procession paths round a now completely ruined pagoda. They represent the march, battle, and flight of some foreign army, represented in true Indian fashion with elephant, monkey, and other animal faces. Some of the figures are clad in Siamese and Cambodian fashion. The glazing is remarkably good, and Indian influence is clear in their construction. They may probably represent a scene from the *Ramayana*, which in a mutilated form is well known to Burmese mythology. These were followed by a huge figure of Buddha from Pegu, in his recumbent attitude, which may be referred to King Dhammacheti, who flourished in the fifteenth century. This image is 181 feet long and 46 feet high at the shoulder. It is built of brick, and is well proportioned throughout. Its history is lost, and so was the image itself until 1881. Pegu was utterly destroyed about 1760 by the Burmese,

and the interest in its holy places lost for more than a generation. This image became jungle-grown and hidden from view, and was accidentally discovered by a railway contractor searching for ballast for the line in the neighbourhood. General and detailed views of the Kawgun Cave were shown, exhibiting the wonderful extent of its decoration by a vast number of terra-cotta tablets and images in wood, marble, alabaster, and other materials, and the extraordinary variety and multitude of the objects connected with Buddhistic worship, both ancient and modern, to be found in it. The Kawgun Cave is the richest of those visited by Major Temple, but he explained that he had examined about half a dozen others in the district, and had since gathered positive information from local native sources of the existence of about forty altogether. Many of these are hardly inferior to Kawgun in richness of Buddhistic remains, and several are said to contain in addition ancient MSS., which must now be of inestimable value. A few such MSS. have actually been found. It will thus be seen how great and valuable is the field, and how well worth systematic study by competent students.

Royal Microscopical Society, October 19.—Mr. G. C. Karop, Vice-president, in the chair.—The chairman exhibited and described Messrs. Swift's aluminium microscope, which he believed to be the first microscope made of that metal. The chief point in the instrument was its extreme lightness, the whole when complete, and including the condenser and eyepiece, weighing only 2lb. 10½oz. as against the weight 7lb. 13oz. of a precisely similar stand made in the usual way of brass. It was perhaps not entirely correct to say that every portion was of aluminium, because there were certain mechanical difficulties met with which prevented some portions from being made of that metal; for instance, he believed it was almost impossible to cut a fine screw upon it without the thread "stripping," and it was also found extremely difficult to solder, so that the necessary screws in the instrument were made of brass, the Campbell fine adjustment of steel; the rack and pinion coarse adjustment was also not made of aluminium, and the nose-piece was of German silver.—Prof. F. Jeffrey Bell read a letter received from Mr. H. G. A. Wright, of Sydney, stating that a scale of Podura in his possession was deeply notched, and that an exclamation mark had become detached and projected from the edge. Mr. Wright also sent photomicrographs to support his statement. The chairman said he could not be sure, from the cursory examination he had been able to make, that the exclamation mark referred to was to be seen.—Dr. C. E. Beevor read a paper on methods of staining medullated nerve-fibres, illustrating the subject by photomicrographs, and by a number of preparations under microscopes. The chairman said they were very much indebted to Dr. Beevor for his interesting paper. It was a good thing to be able to differentiate nerve fibres in the ways described, but it was a pity that they could not also so differentiate them as to show from which part of the nervous system they came. If this could be done he need hardly say it would be of great value.—Prof. Bell read a paper by Dr. H. G. Piffard on the use of monochromatic yellow light in photomicrography. Mr. T. Charters White said that he had himself tried a similar process with monochromatic light obtained by using screens and solutions, but the chief difference he found was that it very much prolonged the time necessary for exposure. Mr. T. Haughton Gill said that he had used the copper light filter for the same purpose, and had found that by its aid any good ordinary lens would give as good results as were otherwise obtained by using an expensive apochromatic, because it filtered off all the rays except those which were visually strong. He had not found, in the course of his work, that the use of this light prolonged the exposure, that was to say, that with a magnifying power of ×300 and an exposure of ten minutes, he could get a good strong printing image with the isochromatic plates.—Mr. G. Massee's paper on *Heterosporium asperatum*, a parasitic fungus, was, in the absence of the author, taken as read.

Entomological Society, November 2, Frederick DuCane-Godman, F.R.S., president, in the chair.—Mr. S. Stevens exhibited, for Mr. J. Harrison, a beautiful series of *Arctia lubricipeda* var. *radiata*, which had been bred by Mr. Harrison this year.—Mr. G. T. Bethune-Baker exhibited specimens of *Polyommatus dispar* var. *rutilus*, taken in England by his father about sixty years ago. He stated that it was generally believed that this form of the species was confined to the Continent, but his specimens proved that it formerly occurred in England.—Mr. C. G. Barrett exhibited dark varieties of *Acronycta leporina*, bred by Mr. J. Collins: also a white variety of *Triphæna pronuba*, taken at Swansea.—Mr. M. Jacoby exhibited a specimen of *Sagra femorata*, from India, with differently sculptured elytra, one being rough and the other smooth.—Mr. J. A. Clark exhibited a long series of remarkable varieties of *Liparis monacha*, bred from two specimens taken at Scarborough. Several of the specimens were as light in colour as the typical form of the species; others were quite black; and others intermediate between these two extremes.—The Rev. Seymour St. John exhibited a monstrosity of *Abraxas grossulariata*, and a specimen of *Tæniocampa stabilis*, with a distinct light band bordering the hind margin of the upper wings.—Mr. E. B. Poulton, F.R.S., exhibited two series of imagos of *Gnophos obscurata*, which had been subjected to dark and light surroundings respectively. The results were seen to be completely negative, the two series being equally light.—Mr. F. Merrifield showed a number of pupæ of *Pieris napi*. About eight of them, which had attached themselves to the leaves of the cabbage plant on which they were fed, were of a uniform bright green colour, with light yellowish edgings; of the others, those which had attached themselves to the black net covering the pot, or the brownish twigs which supported it, were dark coloured, with dark spots and lines. Mr. R. Adkin exhibited three bred female specimens of *Vanessa c-album*, two of which belonged to the first brood, and the third to the second brood. One of the specimens of the first brood was remarkable in having the under side of a very dark colour, identical with typical specimens of the second brood. He thought the peculiarity of colouring had been caused by a retarded emergence, due to low temperature and absence of sunshine.—Mr. F. W. Frohawk exhibited varieties of *Satyrus hyperanthus*, bred from ova laid by a female taken in the New Forest in July last.—Mr. F. D. Godman, F.R.S., exhibited a specimen of *Amphonyx medon*, Cr., received from Jalapa, Mexico, having a pouch-like excrescence at the apex of its body.—Mr. C. J. Gahan communicated a paper entitled "Additions to the Longicornia of Mexico and Central America, with notes on some previously recorded species."—Mr. W. L. Distant communicated a paper entitled "Contributions to a knowledge of the Homopterous family Fulgoridæ."—Mr. Oswald Latter read a paper (which was illustrated by the Society's new oxy-hydrogen lantern) entitled "The Secretion of Potassium-hydroxide by *Dicranura vinula*, and the emergence of the imago from the cocoon." The author stated that the imago produced, probably from the mouth, a solution of caustic potash for the purpose of softening the cocoon. The solution was obtained for analysis by causing the moths to perforate artificial cocoons made of filter-paper. Prof. Meldola, F.R.S., said that the larva of *D. vinula* secretes formic acid, and Mr. Latter had now shown that the imago secretes potassium-hydroxide, a strong alkali. He stated that the fact that any animal secreted a strong caustic alkali was a new one. Mr. Merrifield, Mr. Hanbury, Mr. Gahan, Mr. Poulton, and Prof. Meldola continued the discussion.—Mr. H. J. Elwes and Mr. J. Edwards read a paper (also illustrated by the oxy-hydrogen lantern) entitled "A revision of the genus *Ypthima*, principally founded on the form of the genitalia in the male sex." Mr. McLachlan, F.R.S., said he attached great importance to the genitalia as structural characters in determining species, and he believed that he could name almost any species of European Trichoptera simply from an examination of the detached abdomens of the males. Mr. O. Salvin, F.R.S., said he had examined the genitalia of a large number of Hesperidæ, with the view of considering their value in distinguishing species. Mr. Bethune-Baker, Colonel Swinhoe, Mr. Lewis, Dr. Sharp, F.R.S., Mr. Hampson, and Mr. Champion continued the discussion.—Mr. S. H. Scudder communicated a paper entitled "New light on the formation of the abdominal pouch in *Parnassius*." Mr. Elwes said he had based his classification of the species of this genus largely on the structure of this abdominal pouch in the female. Mr. Jenner-Weir remarked that a similar abdominal pouch was to be found in the genus *Acræa*, and Mr. Hampson referred to a male and female of *Parnassius* in Mr. Leech's collection, in which the pouch had come away from the female and was adhering to the male organs.

PARIS.

Academy of Sciences, October 31.—On the geometry of position, by M. H. Poincaré.—Observations on M. Berthelot's ommunication regarding the fixation of nitrogen, by M. Th.

Schlœsing. Reply, by M. Berthelot.—On the laws of compressibility of liquids, by M. E. H. Amagat. Deformations of the piezometers were investigated and allowed for in these experiments, and the pressures carried as far as 3000 atmospheres. The liquids operated upon were ether, alcohol, carbon bisulphide, acetone, the ethyl halides, and chloride of phosphorus. In every case the coefficient of compressibility was found to decrease regularly as the pressure increased. At 3000 atmospheres that of water was reduced by nearly one-half its ordinary value, that of ether by two-thirds. This diminution again is greater the higher the temperature. The ratio of the difference of the coefficient to the corresponding difference of temperature, $\frac{\Delta\mu}{\Delta t}$, increases rapidly with the temperature, and decreases rapidly as the pressure increases. The value of $\frac{1}{\mu}\frac{\Delta\mu}{\Delta t}$ also diminishes rapidly as the pressure increases; but whilst for alcohol it grows decidedly with the temperature, for ether it seems sensibly independent of it. It is probable that the ratio passes through a maximum at a certain temperature.—Observation of the comet Barnard (October 12), made at the Algiers observatory with the *equatorial coudé*, by M. F. Sy.—Elliptic elements of the comet Barnard, by M. Schulhof. Discussing the probabilities of the new comet being identical with, or a part of, the comet Wolf, which was subjected to considerable perturbations by Jupiter in 1875.—On the equations of dynamics, by M. R. Liouville.—On the solution of the ballistic problem, by M. E. Vallier.—Displacements of a magnet on mercury under the action of an electric current, by M. C. Decharme. If a light magnetic needle be floated on a bath of perfectly pure mercury, and conductors carrying a current be dipped into the mercury at different places, the needle will, before assuming the position of equilibrium according to Ampère's law, go through a series of excursions, rendered necessary by the difficulty of its motion, perpendicular to its length. If the current crosses the mercury in a direction perpendicular to the length of the needle for instance, with the negative pole of the current on the left of the south-seeking pole, the needle will move away parallel to itself, will turn round, and return to take up the normal position.—On the temperature of maximum density of mixtures of alcohol and water, by M. L. de Coppet. The lowering of the freezing-point in solutions of alcohol is sensibly proportional to the quantity of alcohol, in confirmation of Blagden's law. But the lowering of the temperature of maximum density is not proportional to the percentage of alcohol. For weak solutions there is no lowering, but rather an elevation of the temperature of the maximum.—On the dissociation of barium dioxide, by M. H. Le Chatelier.—On a limited reaction, by M. Albert Colson.—On the fixation of free nitrogen by plants, by MM. Th. Schlœsing, jun., and Em. Laurent.—Purification of drain waters by ferric sulphate, by MM. A. and P. Buisine.—Experiments on bread and biscuit, by M. Balland.—Ptomaïnes extracted from urines in erysipelas and puerperal fever, by M. A. B. Griffiths.—Hermerythrine, a respiratory pigment contained in the blood of certain worms, by M. A.-B. Griffiths.—Morphology of the skeleton of the star fish, by M. Edm. Perrier.—The secreting apparatus of the *Copaifera*, by M. Léon Guignard.—New observations on sexuality and parasitic castration, by M. Ant. Magnin.—A possible cause of the doubling of the canals of Mars; experimental imitation of the phenomenon, by M. Stanislas Meunier.—Devonian and permio-carboniferous of the Aspe valley, by M. J. Seunes.—A short account of the voyage of the *La Manche* to Iceland, Jan Mayen, and Spitzbergen during the summer of 1892, by M. Bienaimé. The maps of Jan Mayen were found to be very accurate, those of Spitzbergen much less so. The barometric changes in Iceland, Jan Mayen, and the Faroes agreed strikingly with those of Great Britain and Scandinavia, while those of Spitzbergen were of a particular order. Pendulum observations gave $g=9{\cdot}82345$ for Jan Mayen, and $9{\cdot}82866$ for Spitzbergen.—Eruption of Etna of 1892, by M. A. Ricco.—The analysis of complex odours, by M. Jacques Passy. Proceeding from very small doses, say of amyl alcohol, two different perfumes will be perceived to increase and then diminish in succession, finally giving way to an odour which soon becomes disagreeable as it increases in strength. The transition from perfume to unpleasant odour is very general in volatile substances.—Immunity against cholera conferred by milk, by M. N. Ketscher.—A new apparatus for hypodermic injections, by M. G. Baÿ.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—A Text-book of Magnetism and Electricity: R. W. Stewart (Clive).—Public Health Problems: J. F. J. Sykes (Scott).—An Elementary Manual on Applied Mechanics: Prof. A. Jamieson (Griffin).—Mind in Matter, 3rd edition: Rev. J. Tait (Griffin).—Arthur Young's Tour in Ireland, 2 vols.: edited by A. W. Hutton (Bell).—Text-book of Elementary Biology: Dr. H. J. Campbell (Sonnenschein).—The Volcanoes of Japan, Part 1, Fujisan: J. Milne and W. K. Burton (Low).—Strange Survivals: S. Baring-Gould (Methuen).—Finger Prints: F. Galton (Macmillan).—Modern Mechanism: edited by P. Benjamin (Macmillan).—Catalogue of Eastern and Australian Lepidoptera Heterocera in the Collection of the Oxford University Museum: Part 1, Sphinges and Bombyces: Col. C. Swinhoe (Oxford, Clarendon Press).—An Introduction to the Study of Botany: A. Dendy and A. H. S. Lucas (Melville).—Hydrostatics and Elementary Hydrokinetics: Prof. G. M. Minchin (Oxford, Clarendon Press).—New Vegetarian Dishes: Mrs. Bowdich (Bell).—British New Guinea: J. P. Thomson (Philip).—Autres Mondes: A Guillemin (Paris, Carré).—Stéréochimie: J. H. Van't-Hoff (Paris, Carré).—Théorie Mathématique de la Lumière, II.: H. Poincaré (Paris, Carré).—Traité de Mécanique: V. Jamet (Paris, Carré).—In Savage Isles and Settled Lands: F. S. Baden-Powell (Bentley).—Stanford's Contoured Map of the County of London (Stanford).—Naked-Eye Botany: F. E. Kitchener (Percival).—Geometrical Drawing: A. J. Pressland (Percival).—Practical Physics, Part 1, Physical Processes and Measurements; the Properties of Matter: Prof. Barrett and W. Brown (Percival).—Beetles, Butterflies, Moths, and other Insects: A. W. Kappel and W. E. Kirby (Cassell).—The Principal Starches used as Food: W. Griffiths (Cirencester, Baily).—Charles Darwin: F. Darwin (Murray).—University College, Nottingham, Calendar, 1892–93 (Nottingham, Sands).—Proceedings a d Transactions of the Royal Society of Canada, 1891 (Montreal, Dawson).

PAMPHLETS.—Report on the Operations of the Department of Land Records and Agriculture, Madras Presidency, 1890–91 (Madras).—Entwurf einer Neuen Integralrechnung: Dr. J. Bergbohm (Leipzig, Teubner).—Leaves from the Book of Nature: L. Piers (Ridgway).—Fossil Mammals of the Wahsatch and Wind River Beds, Collection of 1891: H. F. Osborn and J. L. Wortman.—Present Problems in Evolution and Heredity: H. F. Osborn.—Revision of the Species of Coryphodon: C. Earle.

SERIALS.—Quarterly Journal of the Geological Society, November (Longmans).—Festschrift zur Feier des 150 Jaehrigen Bestehens der Naturforschenden Gesellschaft in Danzig am 2 Jan.' 1893 (Danzig).—Schriften der Naturforschenden Gesellschaft in Danzig, Neue Folge, Achten Bandes, Erstes Heft (Danzig).—Notes from the Leyden Museum, vol. xv. No. 1 (Leyden, Brill).—Journal of the Chemical Society, November (Gurney and Jackson).—Mitteilungen des Vereins für Erdkunde zu Halle a/s 1892 (Halle a/s).—Medical Magazine, November (Southwood).

CONTENTS.

THURSDAY, NOVEMBER 17, 1892.

THE GEOLOGY OF SCOTLAND.

Geological Map of Scotland. By Sir Archibald Geikie, D.Sc., LL.D., F.R.S., Director-General of the Geological Survey of Great Britain and Ireland. With descriptive text. (Edinburgh: J. Bartholomew and Co., 1892.)

THERE have been many attempts to frame a popular definition of man. To call him a "story-loving animal" would not be the worst of them. It may indeed turn out, when we understand monkey-talk a little better than now (and the hope that we may is, we are assured, not unreasonable), then it may be that this will prove to be not an exclusive definition. But this by the way; the description will hold for the present. Hence the delight with which we listen to all that the various branches of history, the history of the growth of knowledge included, have to tell us. It is the stories which first attract us, and they retain their charm long after we have learned that the study of history has other ends to fulfil besides the satisfaction of that craving for story-hearing which lies deep in our being, and the gratification of a natural curiosity to learn about things which we have not seen. But the conviction that history should be to us something more than a string of ancedotes soon forces itself upon us.

In tracing the growth of any branch of knowledge, in noting the steps by which, one by one, each advance has been made good, our interest lies first of all in the acquaintance, almost of a personal character we may say, which we make with the pioneers of a movement of which we see not perhaps the full development but the ripening fruit. We watch with absorbed attention their approach to the unexplored land; we follow them along the tracks by which they first traversed it; we stand by while they note and record all that is novel and characteristic in its features; we mark the birth and growth of the conceptions which their exploring work gives rise to; we live over again their fascinating life of discovery and deduction. But beside and beyond all this, their story, like the stories of all history, carries with it a lesson; and their caution or rashness, as the case may be, in generalizing and drawing conclusions, serves as example or warning to us. We look up to candour and a readiness to court criticism and give up explanations which are shown to be untenable; anything like partizanship and a weakly parental predilection for the children of one's own brain we look down upon with sorrowing pity.

The history of the steps by which a knowledge of the geology of a country has been arrived at is written in the successive versions of its geological maps. The appearance of a map which embodies the results of the latest researches into the geology of Scotland tempts us to look back upon the earlier efforts to unravel the complications of its geological structure. And this all the more because we are dealing with a country in which Geology, as we know it, may be said to have come to the birth; and because it is to Scotchmen that we owe the first showing forth of these principles, whether of observation, deduction, or inductive confirmation, which have been the guide of geologists ever since. To Hutton, the precursor of Lyell, to Hall, the scientific ancestor of Daubrée, and to the line of illustrious followers who have carried on with such brilliant success the work which they started.

Among the earliest attempts to deal with the geological mapping of Scotland are the maps of Macculloch's "Western Islands," which bear the date of 1819. It is hard for us to realize how much of Scotland was at that time without adequate topographical delineation. Our present Ordnance Maps are far from being a credit to the Department which issues them, and the language which attends an attempt to use them on the mountainous moorlands, though not a whit stronger than is justifiable under the circumstances, had better be left to melt into thin air around the spots where it was uttered. But our geological life is one of luxury compared with Macculloch's, whose atlas is one string of apologies for the inadequate maps on which he had to record his observations. The map of the Isle of Man "is obviously very inaccurate, but there was only a choice between it and two others equally unworthy of confidence." The map of Staffa "was drawn under every unfavourable circumstance, and cannot fail to be inaccurate, having been merely paced with the assistance of a pocket compass in a severe gale of wind and rain."

Macculloch seems to have projected, but never completed, a geological map of the whole of Scotland. The materials collected by him were however utilized by the Highland Society in the construction of a general map in 1832.

Passing by the maps of Boué, and a sketch of Murchison's and Sedgwick's, laid before the Geological Society in 1828, we come to the publication of Nicol's "Guide to the Geology of Scotland" in 1844.

In a country where the rocks are so largely unfossiliferous, it is natural, even necessary, that the earliest geological maps should be more of a lithological than a stratigraphical character, and this is the case with the maps so far noticed. In the map which accompanies Nicol's guide, and which he says is based on Macculloch's, some of the main varieties of the crystalline schists are distinguished, but the order in which they occur is not indicated. One colour comprises all the red sandstones, the Torridon, the Old Red, and even the red rocks of Dumfriesshire; under the head of "Porphyry and Trap" are lumped together all the volcanic rocks, including those of the western islands and of the central valley; only two of the groups which we now call formations are separated, the "Carboniferous" and the "Lias and Oolite." But the great leading features in the physical geography of Scotland are sharply marked out, the three regions into which it naturally falls are lucidly delineated, and the work is crowded with local details that betoken acquaintance with the work of others and patient investigation of his own.

At the meeting of the British Association at Glasgow in 1855 Murchison gave an account of the result of the joint work of Nicol and himself in the north western Highlands. The existence of three great sub-divisions had been clearly established; what we now know as the Hebridean or Lewisian Gneiss at the base, the Torridon sandstone resting unconformably on it; while above that, and separated from it by another unconformity, came the

limestones and quartzites of Durness and Loch Erriboll, in which Peach had recently discovered fossils. The last group appeared to be conformably overlaid by a great mass of crystalline schists, which came to be known afterwards as the "Upper or Eastern Gneiss." Though the fossil evidence was then incomplete, Murchison saw nothing in it to forbid the belief that the Durness beds were of Lower Silurian age, and his conjecture was confirmed by the discovery of better specimens. This conclusion was announced in a paper read before the Geological Society in 1858, in which it was also stated that the author looked upon the Upper Gneiss as metamorphosed Silurian.

In the meantime Nicol had read a paper before the Geological Society (1856), in which he describes the joint explorations of himself and Murchison, and some subsequent work of his own. He recognizes the same main sub-divisions as Murchison, but still leans to the old notion that the Torridon sandstone belongs to the Old Red; this involves the assigning a later date to the Durness Beds, and these he thinks may be Carboniferous. But he is content to hold this merely as a provisional hypothesis till further fossil evidence is forthcoming. With respect to the Upper Gneiss he is very cautious, suggesting that it may be a newer metamorphic group, or may be merely a portion of the lower, that is Hebridean, gneiss *forced up by some great convulsion.* This latter solution was evidently present very vividly to his mind, for it is repeated, as a possible explanation, no less than three times.

Here a very important difference of opinion between Murchison and Nicol makes its appearance.

It was probably about this time, but the map bears no date, that Nicol issued a new geological map of Scotland. In this all gneiss is denoted by one colour; but the explanation states that the author does not consider all the Scotch gneiss to be of the same age; that the tract of this rock, with associated quartzite and limestone, stretching from Aberdeenshire through Perthshire to the Breadalbane Highlands of Argyllshire, may be a newer formation; while he is disposed to look upon the great mass of gneiss, extending from the north coast of Sutherland southwards through Ross-shire and Inverness-shire, rather as belonging to an older period. The Torridon sandstone is distinguished by a separate colour, though the author is still inclined to class it with the Old Red.

Nicol expounded his views to the British Association at Aberdeen in 1859, and again in a paper read before the Geological Society in 1860. He adduces many reasons for doubting the existence of an "upward conformable succession" from the Durness Beds to the Upper Gneiss, and explains the sections on the supposition that this rock is the Hebridean Gneiss brought up by faults. Though the expressions, "forced up by convulsion" and "pushed up over," which he uses in his paper of 1856, seem to show that the notion of what we call "Thrust Planes" was present to his mind, the sections of this paper hardly bear out that inference. He neatly twits Murchison with failing to see that the principles which he had applied with such success to an explanation of the structure of the Alps were equally applicable to the North-west Highlands. In 1861 Murchison stoutly maintained his view regarding the Upper Gneiss; with an advocate's skill he hits Nicol hard on his weak point, justly urging "that local interferences of eruptive rock nowise set aside broad data." In the same year was issued the "First Sketch of a new geological map of Scotland by Sir R. I. Murchison and A. (now Sir A.) Geikie," in which Murchison's views vere adopted.

Here then was a promise of a fair stand-up fight between two champions, each well able to hold his own. But the promise was not fulfilled. The combat would have been far from equal. On the one side there were the pull which wealth and social position bring with them; the advantage which accrues from living in London and having thus the ear of a great centre of scientific life; and that pushing ambition, that eagerness to secure precedence in discovery, which so often go along with an active and energetic disposition. On the other side there were comparative social insignificance; residence in a hyperborean region far more difficult of access than now; a happy indifference to fame based on a confidence that the settlement might be safely left to time, and that the world would go on pretty much as heretofore, whichever of the two turned out to be nearer the truth: more than all a reluctance to embitter the closing years of life with anything that looked like an altercation with an old and esteemed friend and fellow-worker. So, because it takes two to make a quarrel, the fight never came off. Naturally, under these circumstances, (and can we blame it?) the world took the man who vigorously pushed his views, at his word; he had plenty to say in their favour and said it well; no one gainsaid him; his contention was accepted. There will be those who, without presuming to blame, do not covet success on such terms; and whose sympathies go out towards the peace-loving old man who was content to bide his time and possess his soul in silence.

And so the "Upper Gneiss" and "the upward conformable succession" held their own; and in the geological map of Scotland, issued in 1876 by the present Director-General of the Geological Survey, the crystalline schists of the Central Highlands are designated "Metamorphosed Lower Silurian." It would be tedious to enumerate all the points in which this map is an improvement on the "First Sketch" of 1861, but the student will find it an instructive exercise to compare the two maps, and ascertain by reference to memoirs on special districts how each correction and addition was arrived at.

The Highland problem remained in abeyance for nigh a quarter of a century, though during that interval the minds of many geologists were constantly recurring to it and evidence was being accumulated to help towards its solution. But it came to the front again, and like a giant refreshed with sleep, when Prof. Lapworth in his "Secret of the Highlands" (1883), and other workers in the same ground, began to throw doubt on the explanation which had so long held the field. When the Geological Survey were able to take up the question and work out the ground with precision and detail that no observer could attain to single handed, the anticipations of their immediate predecessors were substantially confirmed, and of the earlier observers it came out that Nicol was nearer the truth than his illustrious antagonist.

It calls for no small exercise of judgment, in an endeavour to depict the geology of so complex a district on

a map of small scale, to decide what details must be retained because they are essential to a grasp of its broad general structure, and what may be safely eliminated without impairing the comprehensive view. In the map now before us this end has been compassed with consummate skill. It bristles with detail, but there is nowhere crowding; the colours are well contrasted, and so transparent that they do not hide the topography, which is full and clearly printed.

The richness in detail of the strip of country between Cape Wrath and Loch Torridon marks one scene of the recent work of the Geological Survey. Then follows a broad band of "gneissose and schistose rocks not yet differentiated." A portion of this ground is occupied by the crushed and mangled-out complex of the "Moine schists," but a large part is yet imperfectly explored. To the south-east of the Great Glen we enter again on ground which has been largely worked out by the Geological Survey. We have here a group of various sedimentary deposits in a more or less altered condition, containing sheets of basic igneous rocks. The geological age of this series is not known, and they are provisionally classed as Dalradian.

The presentation of the results of the work of the Geological Survey in the north-west and central Highlands are the two most conspicuous novelties in the map; but during its use other corrections and additions, too small to catch the eye on a general view, become noticeable. In the explanatory notes we have a concise summary of the geology of Scotland, and feel that our thanks are due to the author for having put so much into so small a space without in any way sacrificing descriptive clearness. When the time comes for a new version of the map, may the same hand be with us to draw it up.

A. H. GREEN.

MEDICAL MICROSCOPY.

Medical Microscopy. A Guide to the Use of the Microscope in Medical Practice. By Frank J. Wethered. M.D.(Lond.), &c. With Illustrations. Pp. 412. (London: H. K. Lewis, 1892.)

THIS volume, one of Lewis's practical series, bears an ambitious title, and must necessarily traverse a wide and intricate field of medical work. Its appearance is justified by the distinct need existing at the present time for a manual dealing with the various microscopical methods so essential to diagnostic accuracy and rational treatment.

The subject-matter is arranged in twenty-four chapters; and as an indication of the scope of the book, we instance some of the headings. The earlier ones treat of the microscope and its accessories, the methods of hardening, decalcifying, embedding, section cutting, staining, and injection of tissues. Then follow others on the examination of tissues, urinary deposits, blood, expectoration, and the detection of micro-organisms, and cutaneous parasites; while the latter chapters deal with the examination of food, water, and with bacteriological methods. In fact, the book is almost an epitome of the course pursued by a student earnestly working with the microscope from the commencement to the end of his curriculum. The tendency has been, by the specialized character of the primary examinations in late years, to sever in some degree the knowledge obtained in the earlier part of a student's career from the practical application of the same at the bedside. So much is this the case, that it has been deemed advisable in some quarters to introduce new courses of lectures, their aim being to indicate with precision to students those facts in anatomy and physiology which have a distinct clinical value. One of the chief merits of Dr. Wethered's book is that he has therein demonstrated the important relationship between histology and morbid anatomy, and has shown that any attempt at acquiring a knowledge of the latter is dependent upon a practical and searching training in the former.

Moreover, the book is worthy of more detailed criticism. Necessarily in a first edition there are some points omitted. In speaking of the microscope the author offers a cursory remark on the fine adjustment; no mention is made of the best pattern, and there are many of an inferior and useless description foisted on students; nor are there any directions for the precise use of this portion of the microscope. In the chapter on "Hardening and Decalcifying Tissues," on p. 35, are found some well-meant platitudes on the necessity of immediately labelling specimens; but at the same time the use of lactic acid as a decalcifying agent is omitted. We have succeeded in completely softening small pieces of bone in 4-7 days, and teeth may be cut with the freezing microtome in from two to three weeks.

With certain statements of the author we venture to disagree. In speaking of the celloidin method he advises that the specimen be placed in equal parts of ether and alcohol previously to being placed in celloidin. A mixture of four parts of ether and one part of absolute alcohol ensures more rapid and complete penetration of the embedding material. Also in using paraffin for this purpose we have found by extensive practice that sections containing a large amount of fibrous tissue are useless after being in the paraffin bath for three to five hours, even at a temperature of 48° C.; twenty to thirty minutes is ample, provided that the material is properly dehydrated. The chapter on staining is succinct and comprehensive, and we note the usual and indeed only rational classification of stains, as nuclear, general, and selective. Hæmatoxylin still holds the first place, and Delafield's, or as it is miscalled, Grenacher's, is undoubtedly the best formula. It is here stated that if the sections be overstained, and washing in acid-alcohol be necessary, the colour is not permanent. Our experience is that if after the acid they be washed thoroughly well with "tap water," a very clear nuclear stain results which remains unchanged for years. Gram's method of staining for micro-organisms, with Weigert's modification, is clearly detailed. But here we fail to observe any mention of the brilliant results obtained by the Ehrlich-Biondi method. The employment of rubin for actinomycosis may with confidence be recommended, and the same remark applies to the use of saffranin in bringing out clearly the nuclear figures in karyokinesis. The chapter on mounting is somewhat tedious and the use of origanum oil in clearing celloidin-specimens is not advocated, although it has found general acceptance in Continental laboratories.

Weigert's method of preparing and staining nerve-tissue is given, but with one important detail left out, viz., that on removing the specimen from Müller's fluid or chromic acid solution it should have a brown, and not a green colour. The preparation of individual tissues and organs is well dealt with in chapter xii., but in the succeeding one on the examination of tumours there are such evident signs of hasty composition as to render it of small intrinsic value. On the other hand, the important subjects of urinary and excrementitious matters receive ample treatment; and we have a clear *résumé* up to this date of all that is taught on these subjects. As an example we note with pleasure the account of Dr. Delepine's work on "sable intestinal." The bacillus of Asiatic cholera and the methods of its detection are described on p. 228; and the diagnostic points between it and that of cholera nostras are found on the next page. A large amount of space is necessarily devoted to the examination of sputa. Dr. Wethered's experience at the City of London Hospital for Diseases of the Chest enables him to speak with the voice of authority on the signification of the presence or absence of the tubercle bacillus. Physiologists will find their side of the question well considered in the observations on blood; on Dr. A. Garrod's authority we are told that the blood of the Londoner has not yet been found to contain its true proportion of hæmoglobin. Eosinophile cells are not omitted; but for more detailed information on this point we commend to the notice of pathologists the article by Dr. A. Kanthack in the *British Medical Journal* of June, 1892.

Medical microscopy as a subject is exceedingly elastic, and we believe Dr. Wethered has stretched it to its widest limits when he finds space for describing the examination of various kinds of cereals, also of water. Even the homely tea-leaf has not escaped his notice. A few instances of clerical errors are to be found, thus Hartnach for Hartnack, on p. 122, Richert for Reichert. At the term "collodionization" we venture to express our distaste. A growing practice exists of introducing ungainly expressions of doubtful expediency into scientific works.

We have read this book with considerable attention, and are convinced that it has a most distinct *raison d'être*, and justifies on the whole, by the merit of its execution, the ambition of its title. It treats of the matter in hand with much ability, and in a manner that evidences considerable experience on the part of the author as a pathologist, physician, and teacher.

A. H. TUBBY.

ODOROGRAPHIA.

Odorographia: a Natural History of Raw Materials and Drugs used in the Perfume Industry. By J. Ch. Sawer, F.L.S. (London: Gurney and Jackson, 1892.)

CONSIDERING the importance of the subject of perfumes both from a scientific and a commercial point of view, it is somewhat surprising that a really good and authoritative book dealing on the matters encompassed by "Odorographia" has not before been attempted. The delay in the appearance o such a work is probably due to the fact that but few persons possess the requisite knowledge to treat the subject in a thoroughly satisfactory manner in all its bearings, such as the origin and production of the numerous products, whether animal or vegetable, and the chemical aspect of every substance and its commercial value, which are points that could scarcely be expected to be mastered by one mind. In the "Pharmacographia" of Flückiger and Hanbury, two master minds on the subject of drugs were brought into co-operation, with the result that a most satisfactory and standard work on medicinal plants was produced. That this book was in the mind of the author when he compiled his "Odorographia," and selected its title, is quite apparent, and we are bound to say that on the whole he has done his work remarkably well, though we wish that he had adhered more strictly to the lines of his pattern. Mr. Sawer, however, at the very commencement of his preface, is so modest as to say that "an endeavour has here been made to collect together into one manual the information which has hitherto been only obtainable by reference to an immense number of works and journals, English and foreign, in many cases inaccessible to readers interested in the subject," and that he is thoroughly well acquainted with all that has been written is apparent not only from a glance through the pages, where numerous references occur, but also from the "List of Principal Works referred to." Besides this the author has, as he tells us, obtained information first hand from some of the largest perfume-plant growers and manufacturers of Grasse, Nice, and localities in the Straits Settlements and West Indies. The difficulties attending the compilation of a work of this nature have, no doubt, been very great, because scraps of information are so widely dispersed, and even when found oftentimes very confusing. The botany alone of the subject must have occupied a considerable amount of time in looking up, the plants yielding perfumes being natives of various parts of the globe, and consequently described in the several floras appertaining to those special countries, besides which the chemical and commercial aspects occupy a large portion of the book.

Though we are grateful to Mr. Sawer for giving us a book that was really wanted, we regret, as we said before, that he has not followed more closely the plan of the "Pharmacographia" and arranged his matter under distinct heads, such as History, Botany, Cultivation, Chemistry, Commerce, &c. Practically he has done so to a certain extent, but the paragraphs are not sufficiently distinguished to enable one to turn at once to that upon which information may be specially sought. The arrangement of chapters, in which the most important and marked odours, such as those of musk, rose, violet, the citrine odours, &c., are brought together, is good, but the principal plants in each of these groups might have been treated as we have described, the least important ones being given as they are at the end of the chapters.

Returning to the botany of the book, we cannot but think that the author might well have spared much space by the omission of numerous varietal names and synonyms, many of which are scarcely ever heard of now, and which often only tend to confusion. Under Violet, for instance (p. 104), half a page is given to a list

of the names of nine varieties of the Sweet Violet (*Viola odorata*). Again, at p. 309, Vétiver, or Cus Cus, is rightly described as the root of *Andropogon muricatus*, after which follow the names of five synonyms. In reference to this Mr. Sawer says, referring to the "Asiatic Researches," that "there is a verse in the Sanskrit language composed of nine words, arranged in two lines, purporting to be the nine names under which the plant was known ; doubtless they were poetical names, as they are not found in the extensive list of local names recently enumerated by Watt." This would show that Dr. Watt, who in his "Dictionary of the Economic Products of India" does not err on the score of brevity in the adoption of synonyms, considered that there was a line to be drawn somewhere. We may perhaps also be allowed to draw attention to a paragraph on page 19, where the musk tree of Jamaica and the muskwood of Australia have got confused. The paragraph in question runs thus: "The *Eurybia argophylla* or *Guarea Swartzei*, the silver-leaved musk tree of Jamaica, New South Wales, and Tasmania, is a meliaceous tree, attaining a height of twenty-five feet." Eurybia, or more properly *Olearia argophylla* is the muskwood of New South Wales and Tasmania, and belongs to the natural order Compositæ, while *Guarea Swartzii* is a meliaceous tree of Jamaica, where it is known as musk tree. Another muskwood, not mentioned by Mr. Sawer, is that of *Moschoxylum Swartzii*, a highly fragrant resinous tree, closely allied to *Guarea*, and a native also of Jamaica and Trinidad. We refer to these matters in no captious spirit, but simply with the hope that Mr. Sawer may see his way to overhaul and modify this part of his useful book in a future edition, so as to make it even more useful and trustworthy. We are glad to note that he "is still engaged upon studies in this department, and hopes to publish another volume in due course."

OUR BOOK SHELF.

Catalogue of Eastern and Australian Lepidoptera Heterocera in the Collection of the Oxford University Museum. By Colonel C. Swinhoe. Part I. Sphinges and Bombyces. (Clarendon Press, 1892.)

This volume is the first part of a Catalogue of the moths from the Oriental and Australian regions in the collection of the late Mr. W. W. Saunders, which was acquired by the Oxford Museum some fifteen years ago, and consists chiefly of specimens collected by Wallace during his famous voyage to the Malay Archipelago, and described by the late Francis Walker in his British Museum Catalogue. Since Walker's arrangement of the collection it has remained untouched and mostly neglected by lepidopterists, so that a rearrangement and comparison of the types had become highly necessary, which useful work has been undertaken and very ably carried out by Colonel Swinhoe. All the types have been brought to the British Museum, their synonomy carefully worked out and the species placed in their proper families and genera, many of them being figured in the eight coloured plates, and it is to be hoped the other parts will soon follow, and also that a list of the types which should be in the Museum and are missing will be added. There is one statement in the preface which requires correction ; the only types of Walker's species described in his Catalogue which are in the Oxford Museum are those which are expressly stated to be in "Coll. Saunders," all the others are in the British Museum, including those for which a locality is given before the list of British Museum specimens.

Charles Darwin: His Life Told in an Autobiographical Chapter and in a Selected Series of his published Letters. Edited by his son, Francis Darwin. (London : John Murray, 1892.)

Prof. Darwin describes this volume as practically an abbreviation of the well-known "Life and Letters." The task of compression has been accomplished admirably, and there can be little doubt that the work will be cordially appreciated by a large number of readers. Of course it has been necessary to omit many details which are of interest to men of science ; but everything is included which is really essential to a proper comprehension of Darwin's fine personal character, and a sufficiently full and clear idea is given even of his scientific labours. No one will read this fascinating book without feeling anew how much reason England has to rank Darwin among the greatest and noblest of her sons. The volume is enriched with a reproduction of an exquisite photograph of Darwin by the late Mrs. Cameron.

Strange Survivals: Some Chapters in the History of Man. By S. Baring-Gould. (London: Methuen and Co., 1892.)

Every one who has given any attention to anthropology is aware that many remarkable customs and beliefs, which are still to be found among the uneducated classes even in highly civilized communities, are relics of ancient superstitions. In the present volume Mr. Baring-Gould examines various groups of these curious survivals, and traces them back to their origin in the ideas of past ages. He knows his subject well, and, being interested in it himself, is able to present it in a way which is likely to make it interesting to others. The value of the text is considerably increased by some well-selected illustrations.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

Botanical Nomenclature.

In Nature for October 6 (p. 549) there is a note "on the progress of the negotiations concerning the nomenclature of genera, started by a committee of botanists at Berlin to supplement the decisions of the International Botanical Congress held at Paris in 1867." It is stated that "the botanical authorities of the British Museum favour the suggestions ; those at Kew are against them."

Now this requires a little correction. It may be remarked to begin with that many botanists are exercised at the present time not merely about the nomenclature of genera, but also about that of species. Kew has, however, never given its adhesion to the attempts that have been made to bring about an international agreement on these matters. It has always felt that so many considerations must determine the course taken by the systematist in any particular case, that there is no advantage, but positive inconvenience, in being subjected to a hard and fast rule. It is therefore with no disrespect to, or want of sympathy with, the able school of Berlin botanists, who have recently formulated some new proposals with regard to nomenclature, that Kew has officially refrained from expressing any opinion upon those proposals. It has neither expressed approval nor disapproval.

In America Harvard has long occupied the leading place in the botanical world, and the principles adopted there have been substantially in accord with those adopted at Kew. Hitherto,

therefore, the leading English-speaking botanists who have occupied themselves with systematic botany have been in substantial agreement that the adoption of a strict law of priority in nomenclature must give way to considerations of convenience.

Well known and accepted names are not therefore to be lightly changed as the result of mere bibliographical research. As to specific names the often merely mechanical process of describing a new species is held to be of little value compared with the more difficult task of assigning to the plant described its true affinities and correct systematic position. The principle which guides Kew practice in this matter is laid down by Sir Joseph Hooker in the preface to "The Flora of British India" (p. vii). He remarks:—

"The number of species described by authors who cannot determine their affinities increases annually, and I regard the naturalist who puts a described plant into its proper position in regard to its allies as rendering a greater service to science than its describer when he either puts it into a wrong place or throws it into any of those chaotic heaps miscalled genera with which systematic works still abound."

The following paper on the subject deserves the wider circulation which its reprint in NATURE would give it. It represents the Harvard tradition and practice, and is the last scientific utterance of Dr. Sereno Watson, who so soon followed to the grave his illustrious predecessor, Asa Gray.

Kew, November 14. W. T. THISELTON DYER.

ON NOMENCLATURE.[1]

[It was the request of the late Dr. Sereno Watson that the following communication, dictated by him in his last illness, should appear at an early date in the *Botanical Gazette*.—EDS.]

FOR some time I have had a desire to give expression to my views upon botanical nomenclature. Under the circumstances, I must speak briefly and somewhat dogmatically. In my opinion botany is the science of plants and not the science of names. Nomenclature is only one of those tools which is necessary to botany, and this being the case, points of nomenclature should be subordinated to science.

A principle of botanical convenience has been established by those who prefer one name to another on account of expediency or convenience. This principle should have a great deal of influence. It has been so recognized by the greatest botanists, and from their authority receives great weight. I prefer the word *expediency* as a better term than convenience to designate the principle, that the demands of science over-ride any merely technical claims of priority, &c.

Priority of specific names appears to be based entirely upon one section of the code of 1867. That simply says that when a species is transferred from one genus to another, the specific name is maintained. This principle is usually understood and applied in the way that the oldest specific name has a right in all cases to be retained. It cannot fairly be so interpreted and applied, since it governs only to the extent that this should be the law, but it is not to be made an *ex post facto* law. Thus when a transfer has been made, that ends the matter so far as the choice of a specific name is concerned, and no one is authorized to take up a different name. This practice of retaining the oldest name *under the genus*, no matter what older specific names there may be, was adopted by Dr. Gray in his later years and by the Kew botanists, for the reason that once established and pretty generally recognized, it would avoid the great mass of synonymy, which is being heaped like an incubus upon the science. I must express surprise that Dr. Britton had not considered it his duty to publish the last written words of Dr. Gray which were addressed to him upon this subject and which expressed his positive opinions upon this point.

There is nothing whatever of an ethical character inherent in a name through any priority of publication or position which should render it morally obligatory upon any one to accept one name rather than another; otherwise it would be applicable or true as well in the case of ordinal names, morphological names, teratological, and every other form of name, to which now no one feels himself bound to apply the law of priority. The application of this law as at present practised by many botanists, which would make it the one great law of botanical nomenclature, before which every other must yield regardless even of common sense, is a mere form of fetichism exemplified in science. Many instances of the application of this law are not science but are rather superstition.

SERENO WATSON.

February 22, 1892.

[1] From *Botanical Gazette*, vol. xvii.

The Reflector with the Projection Microscope.

THE lantern is now used for so many purposes—scientific, photographic, and recreative—that any improvement in its construction will be acceptable. When we look into this instrument whilst at work we must be disappointed at the large quantity of light lost by reflection and by dispersion—light which ought to go to the illumination of the screen. In the ordinary form of the lantern three lenses of dense glass are employed as condensers. Each of these six surfaces reflects and scatters the light, and the glass itself is absorbent of its rays.

The dioptric construction of the projection lantern has been well worked out by Messrs. Wright, Newton, Salomons, and others, but the catoptric principle, which would eliminate almost entirely these disadvantages, has been scarcely at all studied.

Although my experiments have been made solely with the limelight in various forms, the following remarks may equally apply to light given by the electric arc:—

If a reflector be used instead of the ordinary condensers it is obvious that the position of the lime cylinder must be reversed. This will present no difficulty, for the tube holding the jet can be bent into a helical form. The dark image of the lime-cylinder also will have no more practical disadvantage than is experienced by a like image formed by the small plane speculum of the Newtonian telescope.

As to the mirror itself, although a parabolic form is the most correct, a spherical surface will be sufficient for mere illuminating purposes, and thus expense may be spared in the grinding of the more difficult curve. A speculum of from 5 to 7 inches diameter, having a radial curvation of from $2\frac{1}{2}$ to 3 inches, will grasp a large quantity of light, much more than that obtainable from the 5-inch condenser usually employed.

Silver deposited by one of the various reducing processes on the surface of a clear glass lens will have many advantages over a metal mirror. The front surface will give perhaps the finest definition, but by silvering the back part of a spherical glass film, or that of a ground lens, the brilliant surface will remain untarnished for an indefinite time, and the whitish bloom formed by slow volatilization of the incandescent lime is easily removed. This silver film adheres with remarkable tenacity, and it will bear a great deal of heat without blistering or becoming detached.

I have had considerable success in constructing such mirrors from the large ornamental glass spheres blown in Germany, and silvered within by Liebig's process, viz. with milk sugar and ammonio nitrate of silver. A glass sphere of 10 or 11 inches in diameter may be easily cut into eight or nine mirrors by a red-hot iron, and this without disturbing the silvering, which will require only gentle friction with a pad of cotton impregnated with a trifle of rouge to brighten it. Thus, at the cost of a few shillings, eight or more mirrors can be made, and also provision be made against possible accidents of cracking by heat.

The light-radiant is so placed that the secondary focus is intercepted by a plano-concave lens of dense glass, as has been happily proposed by Mr. L. Wright. The convergent rays from the speculum are thus made into a parallel beam, which must be deprived of its heat by an alum-trough, for the light and heat at the substage condenser is very great.

Convergence, I find, is usefully promoted by a plano-convex lens of about eight inches focus, placed two or three inches before the above-noted plano-concave lens. In all other respects the arrangements are like those of the usual modern projection microscope.

I have pretty constantly used the ether-oxygen saturator, and I consider it to be perfectly safe, if ordinary precautions be taken. The oxygen, compressed in cylinders, is much recommended, as there can be no mixture of vapour, except at the right place. The U-shaped horizontal saturator, plugged with flannel, must be well charged with ether, or with the best gasolene, and care should be taken, before beginning or ending an exhibition, to shut off the oxygen tap before closing the ether

tap. This will prevent the harmless "snap" from the mixture in the small chamber at the joining of the gas tubes. If a disc more than eight feet be required for the microscope, it will be well to use hydrogen gas instead of ether, since the calibre of the jet cannot in the ether light very well exceed $\frac{1}{16}$ of an inch.

As an extra security, I pack the mixing chamber with asbestos-fibre, moistened with glycerine; but, as before urged, the oxygen must leave the saturator, saturated.

To insure the coincidence of the foci of the reflector with the optical axis of the microscope, it will be well to place three adjusting screws in a triangle behind the mirror, and this last may have both a small vertical and horizontal movement.

I claim for this catoptric arrangement a larger grasp of light than can be got from ordinary lenses, and this may be effected also at a small outlay. For the amateur constructor the plan will afford many advantages. G. B. BUCKTON.

Note on the Colours of the Alkali Metals.

WHEN these metals are heated in a vacuous tube in such a way as to cause an extremely thin sublimate of the metal to condense upon the glass, the film so obtained will be found to possess a beautiful and strongly-marked colour. That this colour is not in any way due to the combination of the metal with any lingering minute traces of oxygen, is evident from the fact that vacuous tubes which have contained the clean and bright metal for years, and in which the metal has been frequently melted and rolled about, and even vapourized in places, and in which, therefore, it is impossible to conceive of any oxygen remaining, will continue to show the phenomenon whenever a portion of the contained metal is heated. The experiment may readily be made by introducing a freshly-cut fragment of the metal into a glass tube sealed at one end and drawn down to a narrow and thickened constriction near the middle. The tube is then drawn out at the open end and connected to a Sprengel pump. As soon as a good vacuum is obtained the tube is warmed throughout its entire length, the pump being still in operation, and the metal heated sufficiently high to cause it to melt and run out of the crust of oxide. When the exhaustion is again as complete as possible the tube is sealed off. The metal is once more melted, the whole tube being at the same time gently heated, and the molten mass allowed to filter through the constriction into the other portion of the tube. The vacuous condition of the tube allows of the metal freely running through an extremely fine aperture, and in this way it becomes perfectly separated from all dross. The tube is then sealed off at the constriction. On gently heating a minute fragment of the bright metal so obtained, by means of a small pointed gas flame, the coloured film of sublimed metal will at once be seen. Viewed by transmitted light, the colour of the film of sodium thus obtained is greenish-blue, inclining to green. Potassium gives a sublimate which is of a magnificent rich purple colour, while rubidium, on the other hand, forms a film which is a pure indigo blue.

In the cases of sodium and potassium, the colour of the metallic sublimates is different from the colour of the vapour as seen when the metals are boiled in an atmosphere of hydrogen. Potassium, it will be remembered, yields under these circumstances a vapour possessing an emerald-green colour, while that of sodium, which appears colourless when seen in small layers, shows a violet or purple colour when viewed through a sufficient thickness.

When the liquid alloy of sodium and potassium is treated in the same way, the sublimate obtained is found to be greenish in colour nearest to the source of heat, quickly shading off to blue and purple as it is more remote from that point, indicating apparently that the two metals sublime separately.

As a means of observing these colour phenomena, this alloy is more advantageously employed than the solid metals themselves, for, by rolling the liquid about, the sublimate may be wiped away and the experiment repeated indefinitely in the same tube.

As to whether the colours of these sublimed films are properties intrinsic to the particular metals, or are merely a function of the physical condition of the substances, it is perhaps rash to dogmatize. A number of other elements have been treated in a similar manner, but without similar results; thus lithium, cadmium, mercury, arsenic, tellurium, and selenium, when heated in vacuous tubes are readily sublimed, but in no case does the film appear coloured. On the other hand, however, it is well known that some of the very malleable metals when beaten out into thin films are capable of transmitting light varying in colour from green to violet. G. S. NEWTH.

Women and Musical Instruments.

IN answer to Prof. O. T. Mason's letter which appeared in a recent number of NATURE (vol. xlvi. p. 561), I may draw attention to the following facts which bear upon a part of the subject which he broaches, namely, the part played by savage women in the use of musical instruments. In the South Pacific the "nose-flute" is very generally, though by no means exclusively, played upon by women. In the account of the voyage of Capts. Cook and King there is in one of the plates a figure of a woman of the Tonga Islands seated under a hut playing upon a "nose-flute." A similar figure of a woman playing upon a "nose-flute" may be seen in plate 28 of Labilladière's "Voyage de la *Perouse*," in the representation of a Tongan double-canoe. Melville ("Four Months' Residence in the Marquisas Islands," p. 251) mentions playing upon the "nose-flute" as being "a favourite recreation with the females." In Wilkes' "U. S. Exploring Expedition," iii. p. 190, there is a description of this instrument as used in the Fiji Islands, and it is stated that "no other instrument but the flute ['nose-flute'] is played by the women as an accompaniment to the voice."

Turning now to another genus of primitive instruments, viz., the "musical bow," we find a peculiar local form, the "Pangolo," occurring at Blanche Bay, New Britain. There are specimens of this at Berlin and Vienna. This instrument is stated by Dr. O. Finsch (*Ann. des K. K. Naturhist. Hofmuseums*, suppl. vol. iii. pt. 1, p. 111) to be only played upon by women of Blanche Bay. Guppy too ("Solomon Islands," p. 142), says that the women of Treasury Island produce a soft kind of music by playing, somewhat after the fashion of a jew's-harp, on a lightly-made fine-stringed bow about 15 inches long.

It cannot, I believe, be said that any of these instruments have been *invented* by women, and it is undoubted that women in savagery but seldom figure as performers upon musical instruments. It would certainly be interesting to collect all the instances recorded. I hope that the above few notes regarding instruments in the South Pacific may be of use to Prof. Mason, and I can only regret that lack of the necessary time prevents my going further into the matter.

University Museum, Oxford, November 7. HENRY BALFOUR.

AN ANCIENT GLACIAL EPOCH IN AUSTRALIA.

A VERY interesting "special report" has just been issued by the Department of Mines of Victoria, giving an account of the remarkable evidences of glaciation observed at a locality about twenty miles south-east of Sandhurst, and about the same distance north of the great Dividing Range.[1] The report is illustrated by a map and sections on a large scale, and by eight excellent photographic prints, showing the character of the deposit on the surface and in railway cuttings, the striated bed rock, and the striated and grooved blocks and boulders, so that full materials are given for the conclusion that we have here an undoubted glacial deposit. A brief summary of this report will therefore be interesting to all students of the phenomena and problems of terrestrial glaciation.

The district now specially described is about fifteen miles in one direction by five in another, and over this area of about thirty-six square miles the conglomerate is continuous, overlying the Silurian rocks of the district. It has generally a rounded or undulating surface, but shows cliffs about 100 feet high in some of the gullies, and its maximum thickness is estimated at 300 or 400 feet, while its highest point is about 700 feet above sea-level. As well seen in the cliffs and several railway cuttings, the conglomerate consists of a matrix of sand and clayey matter containing huge boulders, great angular and sub-angular masses of rock, pebbles, and rock-fragments of endless variety of size, form, and material. Many of these masses are planed, scored, striated, or polished.

[1] "Notes on the Glacial Conglomerate, Wild Duck Creek." By E. J. Dunn, F.G.S. (R. S. Brain, Government Printer, Melbourne, 1892.)

Planing is very common, and is either flat or with a hollow or a convex surface. Some of the intensely hard hornfels blocks have been ground on one or more sides, several planes being sometimes ground on the same stone, while some very hard rocks are deeply grooved. In other cases the striations and scratches are so fine as only to be seen with a lens; while one surface block of very hard material has been ground down and polished, so that it glitters in the sun. In fact, every form of surface-grinding produced by recent glaciation appears to be here present.

The surface of the ground is everywhere strewn with pebbles and boulders, the result of the washing away of the finer materials of the conglomerate; but, besides these, there is a tract of about two and a half miles by one mile near the centre of the conglomerate-area, on the north side of Mount Ida Creek, which is rather thickly strewn with large blocks, termed by the writer "erratics," though they can hardly be erratics in the sense of having been deposited on the present surface by ice. There are forty-five of these blocks, which are either of granite, sandstone, or quartz, and vary in size from 6 feet by 4 feet, to 20 by 12 feet. One of the finest, termed "The Stranger," of coarse-grained granite, is 16½ feet by 10½ feet, and 5 feet thick, the estimated weight being 30 tons. It is planed and scored in a remarkable manner, as are most of the other blocks. It is curious that beyond this limited area only three or four large blocks are found on the surface, while no pebbles or boulders derived from the conglomerate are found more than a hundred yards beyond the present limits of that formation.

A striking feature of the conglomerate is the great variety of rocks present in it, seeming as if "the débris of a continent" had been here gathered together. There are an almost infinite variety of granites, syenites, gneisses, schists, quartzites, sandstones (hard and soft, coarse and fine), slates, shales, conglomerates, amygdaloids, porphyries, vein-quartz, red, yellow, and grey jaspers, and many others. Some of these can be identified with existing rocks, but others are not known in Victoria. In some cases there is what appears to be river shingle, in others the delicate scratches preserved even on soft shale show that the material has not been exposed to any denuding action. There are also sandstone beds of considerable extent and thickness intercalated with the conglomerate, indicating that there were alternating periods of river or current action while the conglomerate was being formed.

The whole of the phenomena here briefly sketched point unmistakably to glacial action; in fact, there seems to be hardly any part of Wales or Scotland where such action is more clearly indicated. There are, it is true, no moraines, because the period when the conglomerate was laid down is too remote, both newer and older pliocene rocks overlying it in some places. Indeed, from fossils found in shales overlying what appears to be a similar conglomerate at Bacchus Marsh, south of the Dividing Range, the writer of the report is inclined to consider the whole formation to be of Palæozoic age. In one part of the area the bed rock is exposed, and this is covered with abundant striations crossing the stratification lines, indicating either powerful glacier or iceberg action.

A list of localities where similar conglomerates have been found is given, showing that they occur to the northward for about 250 miles along the foot of the hills bordering the Murray valley, disappearing under the Tertiary deposits of the lowlands; they have also been met with forming the floor of the auriferous deposits in mines at Creswick and Carisbrook, on the northern slopes of the Dividing Range; and also, as already stated, at Bacchus Marsh, and a few other localities on the south side of the range. We are not told, however, whether similar indications of glacial action occur in these localities. If these deposits are really all glacial and contemporaneous, they indicate an extent of glaciated country that would imply either a very lofty mountain range or the occurrence of a real glacial epoch in the southern hemisphere.

The direct evidence of the superposition of Tertiary rocks of Pliocene age shows that the glacial conglomerate itself is of great antiquity, but no special attention appears to have been given to the question of the age of the so-called "erratics." The fact that they are found in so limited an area seems to show that they are not derived from the conglomerate itself by the process of sub-aerial denudation, and the same thing is indicated by the apparent fact that they all rest upon the present land surface. The photographs seem to indicate this, and nothing is said about their relations to the subjacent conglomerate, or whether any considerable proportion of them still form part of it, merely protruding above the surface, as would certainly be the case if they owe their present position to the mere washing away of the finer parts of the deposit. But, if so, why should they be called "erratics," as distinguished from the blocks and boulders which are still embedded in the formation? If, on the other hand, they are supposed to be true erratics—that is, to have been deposited on the present land-surface by ice agency—they must clearly be much less ancient than the conglomerate itself, or they would hardly retain such fresh-looking striations, grooving, and polishing as some of them exhibit. It is to be hoped that these most interesting deposits will be the subject of very careful study by Australian geologists, since they seem calculated to throw much light on the geological history of the old Australian continent. ALFRED R. WALLACE.

ON THE WALKING OF ARTHROPODA.

IN a letter to NATURE, published January 8, 1891, I described the manner of walking of several insects. Recently I have been able to examine a greater number of Hexapoda, together with several Arachnida and Centipedes, and a few Crustacea. The results of most of these observations were communicated to the Royal Dublin Society a few weeks ago.

I stated in my former letter that most usually the insects examined moved three legs, *e.g.* the 1st and 3rd on one side, and the 2nd on the other, almost, but not quite, simultaneously. In some insects it is the most anterior leg of this tripod which is raised first; in others it is the most posterior. An example of the first case is the cockroach, and of the second the blow-fly. But again exceptions appear to occur in each case. This almost simultaneous raising of the "diagonals" is shown by observations, photographic and otherwise, to be the rule in all the adult Hexapoda which I have examined, except the Thysanura. Of this last group I have observed *Tomocerus longicornus*, and find that, while it often moves by the simultaneous use of the diagonals, it also often raises its opposite legs simultaneously in pairs, especially when the animal is walking on a smooth surface, and using the sucker which is placed on the anterior part of the abdomen.

This use of the opposite legs in pairs was also found very frequently, as well as the diagonal walk, in the larva of one of the Coleoptera, and is always to be observed in caterpillars. Thus it is interesting to find that in one species at least of the Thysanura, which are regarded as having preserved many of the characteristics of primitive insects the adult walks in the same manner as the larvæ of other insects.

It is to be observed that those insects which have long antennæ move them, and apparently the maxillary palps, in accordance with the diagonal rule; for when the front leg of one side is moved the antenna of that side is twitched.

A midge and some arachnids very frequently use the front pair of walking legs as antennæ. The midge which I observed probably belonged to the Cheironomidæ; it often, when at rest, stood on the two posterior pairs of legs with the anterior pair aloft in the air; when walking it moved them much as a beetle moves its antennæ, gently tapping the ground in front of it with them, their motions being always subject to the diagonal rule; in flight the midges often hold the anterior pair of legs straight out in front, while the last pair are held out in a similar manner behind, and probably have the effect of balancing the insect.

The spiders photographed (*Tegenaria Derhamii* and *Tarantula pulverulenta*) also exhibited the diagonal motion and sometimes the use of the anterior pair of legs as antennæ. When, in order to photograph them, these animals were put on a piece of paper floating in a shallow dish of water, so as to confine them without casting a shadow on the space in which they walked, they used frequently to stand on the three posterior pairs of legs at the edge of the paper, while they moved their anterior pair of legs through the air, or touched the water lightly with them. Several spiders—for instance, *Theridion Sisyphum*—have the anterior pair of legs longer than the others, and very frequently seem to use them as tactile organs. Specialization in this direction is carried very far in the Pedipalpi, in which group the anterior pair of legs are very long, thin, and flagelliform.

The wave of motion in one set of diagonals (*i.e.* the 1st and 3rd of one side, and the 2nd and 4th of the other) in the Tarantula sometimes travelled from before backwards and sometimes in the opposite direction; while in Tegenaria it passed on the whole forwards, but sometimes commenced by the raising of one of the middle legs, or by the raising of the two extreme legs of a set.

When confined on the floating island of paper, the Tarantula sometimes, after a good deal of hesitation, took to the water. When on the surface of the water, its legs, and sometimes the under surface of its abdomen, made conical capillary depressions in the surface, so that the water acted as a diffusing lens to the sunlight, and a dark circular shadow surrounded with a bright line appeared on the bottom of the dish corresponding to the depression at the tip of each leg. This suggested a method of determining the weight supported by each leg, for the diameter of the depressions, and consequently that of the shadows, bears some ratio to the weight on the point which causes the depressions. By fixing the leg of a spider on the end of a straw, hung delicately as a balance-beam, and by measuring the diameters of the shadows caused by the depressions in the surface of the water formed by this leg for various positions of a rider on the straw, I find that these diameters are approximately proportional to the weight on the point causing the depressions. Thus, by dividing the total weight of the spider proportionally to the diameters of the shadows, we get approximately the weight on each leg.

Fig. 1 is from a photograph of the Tarantula standing

FIG. 1.

on water; above the spider in the picture is its shadow on the bottom of the vessel, and at the ends of the three posterior pairs of legs in the shadow appear circular shadows corresponding to the depressions made by the legs; and there is also a shadow thrown by the depression caused by the abdomen. The weight of this spider was 30 mgrs. Thus we find that approximately the weights on the legs are the following:—On the right side, 2nd supports 1·875 mgrs.; 3rd, 7·125 mgrs.; 4th, 3·375. On the left side, 2nd, 4·875 mgrs.; 3rd, 5·250; 4th, 3·000; and the abdomen supports 4·500 mgrs. When walking, the Tarantula usually supported all its weight on a tripod formed by the 2nd and 4th legs on one side, together with the 3rd leg on the other side. The weights on the tips of the legs when one photograph was taken were found to be:—On the 2nd right leg, 9·50 mgrs.; on the 4th right, 10·25; and on the 3rd left, 10·25.

Profile photographs also seem to show that the 1st pair of legs are not generally used to support much weight. Fig. 2 is a diagram of the positions of the 1st pair of legs

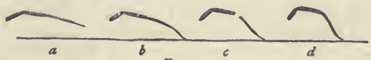


FIG. 2.

drawn from a number of profile photographs of Tegenaria. The first position, *a*, is that of the leg which has been thrown forward, and is just about to come to the ground; *d* shows the position of the 1st leg when the body has come forward, owing probably to the traction of this leg as well as to the pushing of some of the other legs, and so the leg is bent; *b* and *c* are intermediate positions. The next

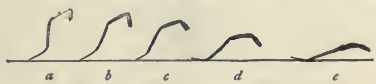


FIG. 3.

figure is a somewhat similar diagram of the 4th pair of legs made from profile photographs. At *a* the leg has just been moved forward, and is on the ground, and is in a good position both for bearing the weight of the body and shoving it forward. At *e* it is stretched to its full length, and so is not of any use in driving the spider forwards, while, owing to its almost horizontal position, it is almost useless in supporting the weight of the body. Accordingly the spider has commenced to raise the extremity of the leg prior to lifting the leg completely off the ground.

Last autumn I had the opportunity of observing two scorpions which Mr. R. J. Moss brought from North Africa and exhibited at the Royal Dublin Society. These also appear to proceed according to the diagonal rule; but I do not know what is the order of succession in one set of diagonals, as I have not yet photographed any of these animals.

The hermit crab uses three pairs of legs in walking—the chelæ, and two pairs of thoracic walking legs; these it uses according to the diagonal rule, whether it walks sideways or forwards. Sometimes it simply shoves the chelæ along the ground without lifting them, while it moves the two pairs of legs in a diagonal manner. One of the Asellidae I found often used the opposite legs in pairs simultaneously when walking.

The centipede does not either raise its opposite legs in pairs together, nor does it move its legs according to the diagonal rule. In a number of photographs taken with an exposure of about the $\frac{1}{40}$th of a second the legs appear to move in threes diagonally, for instance, the 3rd, 4th, and 5th, and the 9th, 10th, and 11th on one side move simultaneously with the 6th, 7th, and 8th of the other side, while on the first side mentioned the 6th, 7th, and 8th, with the 12th, 13th, and 14th are on the ground, and on the other side the 3rd, 4th, and 5th, and 9th, 10th, and 11th are also on the ground. At either end of the body this order is usually more or less disturbed; thus on the right side the 14th leg might be on the ground, while on the left the 13th, 14th, and 15th would be also in contact with the ground; but

in none of the photographs was the symmetrical diagonal movement of the successive threes disturbed between the 2nd and 12th pairs of legs inclusive. This apparently simultaneous motion of three adjoining legs may probably be explained by supposing a series of waves, whose crests traverse three legs in the $\frac{1}{70}$th of a second, to be passing along the body, since the different photographs show different legs moving in threes; thus in one photograph the 6th, 7th, and 8th on the left side are seen to be moving forward, while in another the 5th, 6th, and 7th, are moving.

Since reading the paper at the Royal Dublin Society, Mr. G. H. Carpenter brought to my notice two papers by M. Jean Demoor, "Recherches sur la Marche des Insectes et des Arachnides" (*Archives de Biologie*, 1890) and "Recherches sur la Marche des Crustacés" (*Archives de Zoologie Expérimentale et Générale*, 1891). M. Demoor points out the simultaneous use of the tripod in the insects which he examined, but as he did not use photography he does not seem to have observed the minute want of synchronism of the legs of a tripod. Figs. 4 and 5 illustrate this.[1] These are two photographs taken of the same specimen of *Blaps mucronata*. Fig. 4 is from a photo-

FIG. 4.

graph taken with a long exposure, and shows the 1st and 3rd of the left side, and the 2nd of the right moving at the same time, just as it appears to the eye. Fig. 5 is from

FIG. 5.

a photograph taken with less than half the exposure of 4, and shows that while the 1st leg on the right side is raised off the ground, the 3rd on the same side and the 2nd on the left have not yet been raised. That they have not been raised and are now come to rest is shown by their backward position with regard to the body and other legs. These two photographs also show that the antenna is often twitched almost simultaneously with the motion of the 1st leg of its side. M. Demoor also observed a scorpion (*Buthus australis*), but its method of progression does not seem to have agreed with that of the scorpions (*Buthus europæus*) which I observed. He has not, so far as I know, recorded any observations on spiders.

HENRY H. DIXON.

Trinity College, Dublin, June.

[1] Figs. 4 and 5 show the legs, which are raised from the ground, quite sharp. In the negative they are more or less blurred owing to their motion during the exposure.

ON IRON ALLOYS.

THE merely mechanical expert in the working of metals would naturally consider it probable that a given metal when fused with another would communicate its physical properties, roughly, in proportion to the quantity added. A soft, tough metal added to iron would, from his point of view, render the latter softer; a brittle or hard metal would have the contrary effect, and so on throughout the whole series of metallic alloys.

Actual experiment would soon, however, show the fallacy of this, and that in the majority of cases no reliance could be placed on this assumption solely based on the physical properties of the elements severally considered. A further study of the laws which govern chemical combination would quickly show that alloys formed by fusion were not merely intermixtures, but that something else took place, bodies being often produced, or rather formed, differing considerably from the metals severally used. It would therefore be fair to assume that the metals entered into combination with each other, and yet it would be found that the problem even at this stage was not completely solved.

Further inquiry and experiment would indicate that it was not always possible to prove that chemical combinations "were in all instances" formed by fusion alone. Instead of this something closely akin to only an intermixture of the metals occurred; second, one of the metals had apparently dissolved in the other; third, it was difficult to differentiate betwixt intermixture and solution. Here we are on all fours with modern ideas which seem to have met with general acceptance, although it is not denied that elements or metals are capable of chemically combining with each other. We are not, however, quite prepared to draw a hard and fast line betwixt chemical combination of the metals with each other, solutions, and intermixtures of metals. One appears to merge into the other, and no good reason "so far as is known" can be given why solution, as ordinarily understood, or as defined by Van 't Hoff and others, may not be as applicable to fused metals as to the solution of certain salts in water.

Water at 60° is nothing more nor less than fused ice; fused iron, therefore, may obey the same laws, and, "like water," may be capable of dissolving certain substances, and rejecting others, temperature constituting the sole difference—or plainly, solid ice is fusible at 60°, iron at about 2500°.

Now what happens in the case of water? Certain bodies are soluble in it, others not; on lowering the temperature, these bodies are to a certain extent rejected, and nearly, but not quite, pure ice is formed; and so far as we know this equally applies to fused iron. As an instance, on cooling, the carbon is rejected, and appears in the graphitic[1] form, merely diffused throughout the solid cold metal. It is impossible here to treat this matter in detail; but enough, we think, has been said to indicate that the analogy is fairly complete throughout.

But there is another matter—apart from the solution of foreign bodies in fused ice or iron—which requires to be discussed. Ice dissolves in warm water, and so does cold iron or steel in superheated fused iron; the hot fluid metal from the Bessemer converter fuses or dissolves large lumps of solid steel placed in it as easily as ice is thawed in warm water. Temperature here, in both instances, determines the quantity which can be added; the higher the heat, the greater the quantity which can thus be dissolved or fused, ere the bath becomes thick, pasty, and incapable of being poured out into another vessel.

In so-called solutions the same rule appears to hold good; but, as all chemists know, there are many exceptions; in some cases heat is evolved, in others absorbed; and some bodies are more soluble in the cold fluid solvent.

It is, however, believed that no instance can be quoted of a body being more soluble in iron at a low degree of heat than at a high one. Confining ourselves to hot fluid iron or steel, it apparently readily dissolves cold metal. Similarly, other bodies, such as copper, &c., are dissolved in the same way when added to it.

The cold metal is fused by absorption of the enormous

[1] The relations existing betwixt carbon and iron are peculiar, and require to be separately discussed.

extra heat of the bath, but this may not be strictly true, for something like solution may also take place. In melting iron in the reverberatory furnace it often happens, when the heat is insufficient, that the iron sets in a pasty semi-fluid mass on the bottom of the furnace; the operator then adds some molten iron, and the whole soon becomes fluid.

This process is closely akin to solution. It cannot be explained as simple fusion of iron in iron; the molten iron, in fact, seems to exert a solvent action on the pasty metal, and heat alone plays only a secondary part. This may seem absurd to those not practically engaged in the manufacture of iron, but the fact remains as the result of the experience of iron-workers.

It follows that other metals can be similarly taken up, and the theory of certain iron alloys simplified. There are certain metals intimately related to iron on the periodical scale of the elements, also by atomic volume and atomic weight, and their combination with iron may be achieved by fusion, and possibly something like solution as well, as described, resulting in the production of a similar homogeneous product, which compound metal cannot well be termed either a solidified solution of one metal into another, a chemical combination, or intermixture of metals. The physical properties of this alloy, of course, are different from those of iron. This seems an extreme view to take, but it may be mentioned that the absolutely pure elements prepared by special experts are known in some instances to differ somewhat from those accepted as such in an ordinary laboratory. It has been also noted that the so-called impurity extracted does not differ very greatly from the pure product, and yet is not precisely the same—(quoting from memory, "this applies especially to alumina," why not iron?)

As the result of an extensive experience in the chemical examination of crude iron, steel, and the purest wrought iron, one finds that some metals cling persistently to iron—manganese is always present, nearly all contain copper, nickel also may often be detected if sought for, chromium is not so rare a constituent as might be supposed—all, however, in minute quantities in the case of wrought iron or Bessemer decarbonized metal.

It is curious that these particular metals should cling to iron, but the previous exposition of their relation to iron possibly affords a clue accounting for their persistent presence.

Again, one gathers from a study of Crookes's theory of the genesis of the elements, together with his spectroscopic researches on the composition of the rare earths, yttria, &c., that one so-called element apparently merges into another by almost insensible gradations; it is probable that iron is one of these. Probably it is, for recently it has been all but demonstrated by Prof. Roberts-Austen and others that iron is a compound body, but the relations betwixt these bodies are so close that they have not been isolated, and both are still termed iron.

We have evidence of the possibility of one element merging into another and that iron is not an element, and any one who has studied the periodic law cannot fail to see at least the probability that minute variations in the composition of the elementary bodies may occur, which, however, cannot well be differentiated by our present comparatively coarse analytical methods. Modern methods, however, have been sufficiently accurate to enable us to show that certain relations can be traced throughout the whole series of the elements, and it is in this way that the periodic law has been formulated; and fairly trustworthy atomic weights have been obtained.

Admitting the possibility of minute variations in the composition of elementary bodies, or more correctly that, as urged by Crookes, an element may have more than one atomic weight—the atomic weight accepted being the mean of these: with the periodic law for our guidance, and also attaching due weight to the relations existing betwixt the weights and volume of the atoms, it would seem that the theory advanced of the homogeneous formation of bodies by fusion is in accord with the periodic law, &c., governing the genesis of the elements.

This is equivalent to saying that a fourth state of combination may be imagined, which is—

(1) Neither solution of one metal in another.
(2) Chemical combination of bodies.
(3) Intermixture of bodies.

Hadfield's alloys of iron and manganese may be members of this class.

The first series of these alloys are hard, but when the manganese exceeds 7 per cent. the metal softens; and alloys containing about 12 to 15 per cent. of Mn are strong, tough, cannot be annealed, and cannot be termed either iron or steel.

The same to a certain extent, it is believed, applies to the nickel alloys of iron.

There are other properties, which show that the FeMn alloys are unique.

The alloys of chromium and iron recently made by Mr. Hadfield appear to be of the same class, as also those of nickel and copper with iron.

More plainly, the homogeneous compound bodies previously commented upon may be practically termed elementary bodies similar to the quasi-elements of the rare earths studied by Prof. Crookes. These being, however, within the domain of practical chemistry, it is easy to demonstrate their compound nature, not forgetting "that, as previously noted," it is not easy to entirely eliminate these bodies allied to iron.

We may even go further and assume that the fourth state indicates a species of combination even more intimate than the chemical combination of the chemists.

In fact, reactions "occur quite unlike chemical combination in which atoms only combine with atoms, or bodies are built up atomically." The fourth state may go beyond this; at present this is pure assumption; yet an eminent man of science has suggested that even the atoms may be *smashed*, and this is equivalent to saying that under certain conditions the atom may be non-existent; or in an alloy of, say, iron and nickel or iron and manganese, the separate atoms of iron and manganese do not exist; or in an alloy of iron and Mn or nickel, the severally separate atoms of Fe and Mn, &c., may have no tangible existence apart from each other, as in the case of true chemical combination. Further, this seems more probable if we remember that chemical combinations are, according to modern views, nothing more nor less than structural formations governed by physical laws which regulate their molecular arrangement and the relative positions of the atoms to each other, just as in any structural work built by the hand of man, certain laws or rules must be adhered to. In Nature's laboratory something beyond this may be going on—something, indeed, altogether outside our limited knowledge and experience.

Iron is only one member of a very complicated group, which are closely in accord both as regards their atomic volumes and weights and position on the periodic scale of the elements; and, if we are to accept the work of Prof. Crookes, the well-known investigations of Prof. Roberts-Austen, Osmond, and some data derived from the spectroscopic work of Lockyer, one may be really justified in assuming that quasi-elements may be formed by fusion in the workshop—*i.e.*, elements which can afterwards be dissociated by ordinary chemical processes. The accepted elements, it is true, have not been so dissociated; but it is clear something has been done to indicate the compound nature of at least some of these.

The theory of the possible existence of iron as a quasi element when fused with other elements of like nature clashes with the generally received ideas of chemical

combinations or solution; because undoubtedly these are formed.

Granting that chemical combinations likewise take place, does it not seem probable that when these latter are present they may be strictly termed impurities?

If so, iron alloys may be divided into two classes—(1) those in the homogeneous or fourth state, "the true alloys," (2) those in which chemical combinations or solution only takes place; and this latter class may be termed impure metal, in contradistinction to the first or quasi elementary body.

In conclusion it is urged that many of our most eminent metallurgists and men of science have "by very different modes of investigation" come to the conclusion that iron itself is a compound very complex body. It is true that we have only indirect proof of this, but it only remains to find methods of isolating these bodies from each other.

NOTES.

The medals of the Royal Society are this year awarded as follows:—The Copley Medal to Prof. Rudolph Virchow, For. Mem.R.S., for his investigations in Pathology, Pathological Anatomy, and Prehistoric Archæology; the Rumford Medal to Mr. Nils C. Dunér, for his Spectroscopic Researches on Stars; a Royal Medal to Mr. John Newport Langley, F.R.S., for his work on Secreting Glands, and on the Nervous System; a Royal Medal to Prof. Charles Pritchard, F.R.S., for his work on Photometry and Stellar Parallax; the Davy Medal to Prof. François Marie Raoult, for his researches on the Freezing Points of Solutions, and on the Vapour Pressures of Solutions; the Darwin Medal to Sir Joseph Dalton Hooker, F.R.S., on account of his important contributions to the progress of Systematic Botany, as evidenced by the "Genera Plantarum" and the "Flora Indica," but more especially on account of his intimate association with Mr. Darwin in the studies preliminary to the "Origin of Species." The award of the Royal Medals has been graciously approved by the Queen.

The American Ornithologists' Union has been holding its tenth congress at Washington. The meetings began on Tuesday, and were held in the U.S. National Museum.

James Plant, F.G.S., of Leicester, who has just died in his seventy-fifth year, was well known as a local geologist in the midland counties, and as a member for some years of the Committee of the British Association on Erratic Blocks. Such blocks are numerous in Leicestershire, those on the southern side of the county being chiefly derived from the Charnwood range, and Mr. Plant was diligent in searching out and recording the more important of them. Several large boulders striated and partially polished stand in the grounds of the Leicester Museum, rescued by him from various railway cuttings. In 1868 he collected a very fine series of massive specimens representing all the hard rock formations of his native county, for exhibition at the meeting of the Royal Agricultural Society. These were afterwards built up into a great cone about 8 feet in diameter and 15 feet high in the museum grounds, and when the enlargement of the building necessitated its removal they were formed into a diagrammatic geological section on another site. Having to be again removed two years ago some of them were used to form a rough geological model of Charnwood Forest in the Abbey Park. In his latter years Mr. Plant acted as consulting geologist in several important borings for water and coal. The curious concentric rings on the face of a rock in Charnwood Forest interested him greatly, and with much trouble and labour he succeeded in obtaining plaster casts of them. He was active also in procuring photographs of many of the most remarkable geological features of the district.

Dr. R. v. Wettstein, of Vienna, editor of the *Oesterreichische Botanische Zeitschrift*, has been appointed ordinary Professor of Botany at the University of Prague.

The Prussian Government has decided to introduce the use of the Centigrade thermometer instead of that by Reaumur, which is still in use in some parts, and no further Reaumur thermometers are to be supplied to any public officials. The Centigrade thermometer has long been in use in Germany for scientific purposes.

A valuable collection of fossils, minerals, and shells, comprising several thousand specimens, and particularly rich in specimens from the carboniferous formation, has just been presented to the University College of North Wales by Mr. Evan Roberts, of Manchester. It is hoped that this gift will become the nucleus of an important geological collection suited to the educational requirements of a University College, and that similar gifts will from time to time be made to the College by those interested in the progress of geological study.

The Oxford Medical Society held its first meeting on Saturday last, at the University Museum. Sir Henry Acland presided. The inaugural address was delivered by Sir James Paget. He said they all knew that the practice and science of medicine, or, as it was sometimes called, the science and art of medicine, were by some regarded as things quite distinct, wide apart, and in study almost incompatible. A few there were who had the capacity of pursuing both. The great mass of those engaged in the pursuit of medicine were either practitioners or men devoting themselves to science. Each method of work was essential to the practice of the other. It might be asked how could practitioners work as men of science even where they had the time for it? He believed that would come about by the increase in the teaching of science in all medical schools and Universities. He pointed out the work which might be undertaken by the society, and spoke at length on various subjects which might be studied with advantage. Prof. Burdon-Sanderson said the society had been established for the furtherance and promotion of science, and they wished to make an advance, so to speak, towards the University. There was a yearning in the minds of the medical profession in Oxford to unite itself more closely than it had hitherto with the scientific studies of the University which depended immediately on medicine.

The weather has continued very unsettled during the past week, the most notable features being the prevalence of fog and abnormally high temperature. During the latter part of last week fog extended over nearly the whole of England, as well as a large part of the Continent. In London and the suburbs intense darkness occurred on several days, interspersed with very short intervals of sunshine, but in the north-western parts of the kingdom the weather was generally fair. These conditions were due to the distribution of pressure, which was cyclonic over the western portion of these islands, but anti-cyclonic over western Europe. Temperature was uniformly high for the season, the daily maxima ranging from about 50° to 60°, and reached 62° in several places in the southern counties on Monday. This maximum is the highest that has been recorded in the neighbourhood of London during the last ten years. In the early part of the present week a deep depression passed to the westward of Ireland from the Atlantic, causing southerly gales in the north and west, with rain in all parts of the country, the amount measured at Valencia Observatory on Monday exceeding an inch. On Tuesday afternoon a fresh depression reached our south-west coasts from the south-eastwards, while a trough of low pressure lay over the Bay of Biscay and France, causing further heavy rains and local fogs. For the week ending the 12th instant the reports show that bright sunshine was, as might have been expected, very deficient generally, especially over northern and eastern England, where the percentage of possible duration was only 9; the lowest

amount was at Stonyhurst, where it was only 2 per cent. The south-west of England enjoyed the brightest weather, as there the sunshine amounted to 33 per cent. of the possible amount.

THE current number of the *Annalen der Hydrographie* contains a short note of a hurricane at Marseilles on October 1, which is said to have been more severe than any experienced during the last thirty years. From 8 a.m. until 1 p.m. the wind, rain, hail and lightning were incessant, all the lower parts of the town being under water, while several houses and bridges in the neighbourhood were destroyed. The weather charts for the day show that the storm was caused by a small whirl which occurred on the south-eastern side of a large depression, whose centre lay in the south of Scotland. While the centre of the depression scarcely altered its position, the whirl increased in extent, but diminished in intensity, and on October 3 it had crossed Northern Italy and lay over Hungary.

MR. CHARLES CARPMAEL, director of the meteorological service of the Dominion of Canada, urges in his latest report the need for more thorough inspection of the various stations under his control. He points out that the stations in Great Britain and Ireland, connected with the Meteorological Office, London, are constantly inspected, and that in every country where meteorology is worked out on a large scale inspection is admitted as the only system whereby trustworthy and satisfactory results can be obtained. He recommends therefore that a sufficient appropriation should be placed at his disposal to enable him to have the meteorological stations in the Dominion inspected and the observers thereof thoroughly instructed in the duties required of them. If this is not done the data furnished to the Central Office cannot, he says, be accurate.

TWO numbers have now been issued of the new series of the quarterly cryptogamic journal, *Grevillea*, under the editorship of Mr. G. Massee. It is conducted very much on the old lines, and contains many articles of interest to cryptogamists. It is strange that one peculiarity of the journal should still be retained which detracts very much from its usefulness as a work of reference, the absence of any table of contents or index to each separate number.

THE Cambridge University Press has issued the Sedgwick prize essay for 1886, by the late Thomas Roberts, on the Jurassic rocks of the neighbourhood of Cambridge. The essay has been edited by Mr. Henry Woods, Scholar of St. John's College, and Lecturer on Palæontology in the Woodwardian Museum. In an interesting preface, Prof. T. McKenny Hughes explains the nature of the problem which the author endeavoured to solve, and expresses his belief that the work is indispensable for the student of Cambridge geology, and most valuable for all specialists in the Jurassic rocks.

SIR HENRY H. HOWORTH has completed and will shortly publish a considerable work on which he has been long engaged entitled, "The Glacial Nightmare and the Flood." It begins with an account of the various theories which have been forthcoming to explain the drift phenomena, in which the very large literature on the subject has been for the first time condensed and tabulated. It then proceeds to criticize the extreme glacial views which have recently prevailed among geologists, and to call in question the theory of uniformity as developed by the followers of Lyell and Ramsay, and especially to attack the notion that ice is capable of distributing materials over hundreds of miles of level country, and of producing many of the effects attributed to it by the glacial school of geologists. The author argues that the evidence points to the former existence of much larger glaciers than exist now, but not to an ice period when the temperate regions were covered with ice. On the contrary, these great glaciers existed side by side of fertile plains. Lastly he argues that the phenomena of the drift can only be explained by reverting in a large measure to the diluvial theories of Sedgwick and Murchison, Von Buch and others, and that the purely geological evidence is completely at one with that collected in the author's previous work on "The Mammoth and the Flood," and establishes that a great diluvial catastrophe forms in the temperate zones the dividing line between the mammoth age and our own.

THE Libraries Committee of the Glasgow Town Council, in the eleventh general report on the Mitchell Library, Glasgow, make a suggestion which deserves to be kept in mind. It is to the effect that an admirable way of perpetuating the memory of a relative or friend would be to present a public library with a separate collection of books, to be kept together and called by such name as may seem proper to the donors. "Such a memorial collection," say the Committee, "would, with propriety, be composed of books devoted to any department of literature or learning in which the person to be commemorated was interested or which the donors desired to see more fully represented."

A VALUABLE paper on the present state of Morocco is contributed to the current number of the *Revue Scientifique*, by M. A. Le Châtelier. He brings out very strikingly the mixed character of the population of Morocco. First he notes the fair-haired, blue-eyed type, which is represented in the sculptures of some tombs of the twelfth Egyptian dynasty. Then come the various Berber types, the Arabs, several elements (including the Draoua) which have come down from remote antiquity, Spanish Moors and Jews, and the descendants of Christian captives. M. Le Châtelier thinks we must also take into account descendants of Phenicians, Carthaginians, Romans, Byzantines, and Vandals.

MR. C. H. EIGENMANN has contributed to the Proceedings of the U.S. National Museum (vol. xv.) a paper in which he presents a valuable account of the observations made by him on the fishes of San Diego and vicinity from December 11, 1888, to March 4, 1890. Especial attention was paid to the spawning habits and seasons, the embryology, and migration of the fishes of Southern California. A diary was kept of the occurrence of each species throughout the year 1889 and part of 1890. Mr. Eigenmann's knowledge of the occurrence of each species is largely based on observations of the fish brought into the markets, which he visited twice or thrice daily, and of those caught with hook and line by the numerous habitual fishermen found on each of the wharves, and of those caught by the seiners, whom he accompanied on several occasions. During the early part of 1888 each individual fisherman sold his catch as best he could and the data for this part of the year are not as full as for the latter part of 1888, when practically the whole catch was brought to two markets, where Mr. Eigenmann could see the fish as they were unloaded. The knowledge of the ocean fishes is largely derived from frequent visits to ocean tide-pools, from the fish brought to the markets, and from a two-weeks' stay on the Cortes Banks. As a matter of course, hundreds of specimens of most species have been observed to every one preserved, and the present paper is to be looked upon as a contribution to the economic history of the fishes, rather than to the anatomy of the various species. With two exceptions, the types of the new species discovered, and otherwise interesting specimens, have been deposited in the U.S. National Museum. A nearly complete series of types has been placed in the British Museum, and minor series in the Museum of Comparative Zoology and the California Academy of Sciences.

THE Committee of the Field Naturalists' Club of Victoria have hit upon an excellent plan for interesting the more active members in definite lines of investigation. They have arranged that special meetings shall be held once a month for the carrying on of practical work which cannot conveniently be undertaken

at the ordinary monthly meetings. The first of these special meetings assembled on August 22 in the Royal Society's Hall, Melbourne. We learn from the Club's journal that there was a good attendance of members, those interested in microscopic work being principally represented. No fewer than twenty-four microscopes were set up. Mr. J. Shephard undertook to give a slight sketch of some interesting forms amongst the rotifera. A typical form was first described, the chief points in its structure being made clear by good diagrams, and then variations in the various orders from this type were briefly referred to—special allusion being made to the modifications in the ciliary wreath and the foot. Mr. Shephard had fortunately met with a large number of the Australian member of the rhizotic group (*Lacinularia pedunculata*), and at the conclusion of his remarks a slide of mounted individuals was handed to each member for careful examination under the microscope. Half an hour was profitably spent in the endeavour to make out all the points of detail in the specimens, during which time Mr. Shephard also supplied full information as to the best methods of mounting and examining these interesting organisms. Some four or five entomologists had a quiet corner to themselves, where they compared specimens and talked over some plans for future operations.

AT the ordinary monthly meeting of the Field Naturalists' Club of Victoria, on September 12, the feather boots of a native rain-maker from M'Donnell Ranges were exhibited. It is believed among the natives of certain tribes in Central Australia that droughts are caused by the swallowing up of all moisture by a rain-devil. If this personage can be captured and made to disgorge, rain follows at once. The feather boots are worn by the native rain-maker in order that he may steal noiselessly and unawares on the author of the drought and consequent misery. Mr. A. W. Howitt is having drawings made of these boots, which he considers to be one of the most valuable and interesting additions to aboriginal ethnology yet brought to light.

AN interesting paper on the anthropology of Spain, contributed to the "Anales" of the "Soc. española de Historia Natural" by Luis de Hoyos Sáinz and Telesforo de Aranzadi, has now been published separately at Madrid. The paper is accompanied by three excellent maps, in which, by means of various degrees of shading, the authors bring together a number of most interesting conclusions. One of these maps shows the cranial types which prevail in different parts of Spain.

IN the November number of the *Mediterranean Naturalist*, Mr. John H. Cooke gives an interesting account of his recent discovery of Ursus arctos in the Malta Pleistocene. The late Admiral Spratt and the late Prof. Leith Adams found among the cavern deposits of the Maltese Islands a remarkable land fauna, including elephants, hippopotami, land tortoises, gigantic dormice, and aquatic birds. From the fact that many of the remains of elephants presented the appearance of having been fiercely gnawed, it was concluded that carnivoræ had lived in the district; but, notwithstanding the most diligent search extending over a period of twenty years, the only tangible evidences in support of the inference were these gnawed bones. Mr. Cooke has now solved the problem. His discovery was made in the spring of the present year, when, with the aid of a money grant from the Royal Society, he carried out some excavations in the Har Dalam cavern, a subterraneous gallery situated in a gorge of the same name in the eastern extremity of Malta. After having excavated six large trenches and obtained some hundreds of bones of *Hippotamus pentlandi*, *Elephas mnadraensis*, *Cervus barbaricus*, and numerous other animals, he had the satisfaction of discovering an entire ramus of the lower jaw of a bear, Ursus arctos with its canine and molars *in situ*, as well as five other canines belonging to other individuals of the same species. Afterwards four other canines were discovered, each of which was in a fairly perfect state of preservation. One of these Mr. A. S. Woodward has determined as belonging to the left side of the mandible of a species of *Canis* equalling a wolf in size. Associated with these remains were found several vertebræ and fragments of limb-bones of hippo, and vertebræ and portions of horns of stags; but none of them presented any evidences of having been gnawed.

THERE is some difference of opinion as to whether the process of digestion is promoted or hindered by bodily exertion. Herr Rosenberg recently made some experiments on a small dog with reference to this point (*Pflüger's Archiv.*). The animal was fed once daily with a certain quantity of lean horseflesh, lard, and rice, and the amount of nitrogen and fat daily absorbed was determined by an examination of the excreta. There were five series of experiments, each consisting of a rest period of several days, followed by a working period of several days, the dog being made to work in a kind of treadmill. In some cases these efforts were made during stomachic digestion, in others during intestinal. In both series of experiments the differences observed lay within the limits of physiological variations, the inference being, accordingly, that in a healthy dog the utilization of food is quite independent of whether the animal rests during digestion or is energetically at work. Whether this applies to man could only be determined by direct experiment. Herr Rosenberg thinks it probable, however, as observations on people with heart disease appear to show that the absorption of food is to a certain extent independent of the circulation and distribution of the blood.

THE characteristic mantle of ascidians, consisting of a ground mass with cellulose and embedded cells, has been much studied, especially with regard to the origin of the cells. The most favoured view is that it is produced by the ectoderm, that it is a thickening of the outer epithelium. Recent researches by Kowalevsky, however (described to the St. Petersburg Academy) give reason for believing that the mantle-cells are from the mesoderm. Studying the metamorphosis of *Phallusia mamillata*, he observed certain mesoderm-cells applying themselves to the ectodermal epithelium, penetrating it and entering the mantle, which (secreted from the ectoderm) was before quite transparent. These cells also move freely about in the mantle, and this amœboid movement is further in favour of their mesodermal nature. A similar process occurs in vertebrates, viz., the passage of lymph-cells (leucocytes) through epithelium to the surface of a mucous membrane, or the surface of the body (in fishes); the mucous layer is comparable to the ground mass of the mantle. But in vertebrates the cells at length disappear; whereas in ascidians they persist. Besides their share in the growth of the mantle, they have an important function as phagocytes. In compound ascidians certain individuals are every now and again perishing, and these dying parts are known to be absorbed by the mantle-cells. Also, incoming foreign bodies, such as bacteria, the cells attack and seek to destroy. Numerous bacteria are always present in the mantle of tunicata. Moreover, experiments were made by introducing bacteria through fine glass tubes inserted in the mantle; the mesoderm-cells collected round these tubes, entered them, and fought with the bacteria. Kowalevsky attaches great importance to this function, and supposes the above-mentioned passage of wandering cells to the surface of epithelia to be explained as a means of protection against the intrusion of agents of disease.

MR. L. STEJNEGER gives in the fifteenth volume of the Proceedings of the U.S. National Museum an interesting preliminary description of a new genus and species of blind cave salamander from North America. The discovery of a blind cave salamander in America is regarded by Mr. Stejneger as "one of the

most important and interesting herpetological events of recent years." The discovery is primarily due to Mr. F. A. Sampson, who, in July last year, found the adult animal as well as a larva in the Rock House Cave, Missouri, and forwarded both to the U.S. National Museum. Mr. George E. Harris afterwards went to great trouble in order to procure additional specimens. Unfortunately, he has only succeeded so far in obtaining larvæ, but Mr. Stejneger hopes to be able to secure more adults. A more detailed anatomical description of this interesting animal is postponed until then, as he has not felt justified in mutilating the type specimen beyond what was necessary in order to ascertain the character of the vertebræ. The present preliminary description is, therefore, only prepared in order to call attention to the discovery and to supply the diagnosis by which the animal may be identified.

DR. MORRIS GIBBS contributes to *Science* an interesting paper on the food of humming-birds. He has carefully dissected many humming-birds, both old and young, but has never found anything to convince him that the birds live on insects. It may be that at times when flowers are scarce some species of insects are captured, but Dr. Gibbs is satisfied that in season, when flowers are abundant, the ruby-throat of Michigan lives on honey.

IN a recent investigation of the action of accumulators, Herren Neumann and Streintz have shown (*Wied. Ann.*) that lead has the power of absorbing hydrogen. In one case the metal was used as an electrode, and charged with electrolytic hydrogen; in another it was melted, and a current of hydrogen passed through it. Care must be taken that the charged metal is not in contact with air, as the oxygen of the latter then unites with the hydrogen; and this, the authors think, is why previous observers have not been able to prove an occlusion of hydrogen by the lead plates of accumulators. The authors examined other metals, and they give the following numbers for the gas absorbed per unit volume of metal:—Lead, 0·15; palladium, 502·35; spongy platinum, 29·95; platinum black, 49·30; gold, 46·32; silver, 0·00; copper, 4·81; aluminium, 2·72; iron, 19·17; nickel, 16·85; cobalt, 153·00. When the same pieces of metal were repeatedly used, the occluding power generally fell off; in the case of the noble metals this is thought to be due to increased density; but why the occluding power of iron and cobalt should be reduced to one-half or more was not explained. Nickel and copper retained their power. With regard to the high power of cobalt, the authors tried that metal in a voltameter, but curiously it showed no hydrogen polarization when the charging circuit was opened.

MESSRS. WILLIAMS AND NORGATE's Natural Science Catalogue (No. 9) includes classified lists of books and periodicals on mathematics, astronomy, meteorology, physics, electricity, chemistry, microscopy, optics, mechanics, engineering, technology, &c., in French, German, and other foreign languages.

THE opening meeting of the one hundred and thirty-ninth session of the Society of Arts was held yesterday (Wednesday) evening. The following arrangements have been made for the ordinary meetings:—November 23, "The Disposal of the Dead," by F. Seymour Haden; November 30, "The Copper Resources of the United States," by James Douglas; December 7, "The Chicago Exhibition, 1893," by James Dredge; December 14, "The Utilization of Niagara," by Prof. George Forbes, F.R.S. The following papers, for which dates have not yet been fixed, will be read:—"Transatlantic Steamships," by Prof. Francis Elgar; "The Detection and Estimation of Small Proportions of Inflammable Gas or Vapour in the Air," by Prof. Frank Clowes; "The Purification of the Air Supply to Public Buildings and Dwellings," by William Key; "Pottery Glazes: their Classification and Decorative Value in Ceramic Design," by Wilton P. Rix; "The Chemical Technology of Oil Boiling, with a Description of a New Process for the Preparation of Drying Oils, and an Oil Varnish," by Prof. W. Noel Hartley, F.R.S.; "The Mining Industries of South Africa," by Bennett H. Brough; "Ten Years of Progress in India," by Sir William Wilson Hunter; "Australasia as a Field for Anglo-Indian Colonization," by Sir Edward N. C. Braddon, Agent-General for Tasmania; "Indian Manufactures," by Sir Juland Danvers, late Public Works Secretary, India Office; "Caste and Occupation at the last Census of India," by Jervoise Athelstane Baines, Imperial Census Commissioner for India; "Mexico, Past and Present," by Edward J. Howell; "Newfoundland," by Cecil Fane: "New Zealand," by W. B. Percival, Agent-General for New Zealand. The following courses of Cantor lectures will be delivered on Monday evenings, at eight o'clock: Prof. Vivian Lewes, "The Generation of Light from Coal Gas" (four lectures, November 21, 28, December 5, 12); Dr. J. A. Fleming, "The Practical Measurement of Alternating Electric Currents" (four lectures, January 30, February 6, 13, 20); Prof. W. Chandler Roberts-Austen, F.R.S., "Alloys" (three lectures, March 6, 13, 20); Lewis Foreman Day, "Some Masters of Ornament" (four lectures, April 10, 17, 24; May 1); C. Harrison Townsend, "The History and Practice of Mosaics" (two lectures, May 8, 15). A special course of six lectures, under the Howard bequest, will be delivered on the following Friday evenings at eight o'clock: Prof. W. C. Unwin, F.R.S., "The Development and Transmission of Power from Central Stations" (January 13, 20, 27; February 3, 10, 17).

THE additions to the Zoological Society's Gardens during the past week include a Squirrel Monkey (*Chrysothrix sciurea*) from Guiana, presented by Mrs. K. Betts; a Brown Capuchin (*Cebus fatuellus* ♀) from Brazil, presented by Miss L. Blackburn; a Himalayan Bear (*Ursus tibetanus* ♀) from Burmah, presented by Major W. H. Cunliffe; a Herring Gull (*Larus argentatus*) British, presented by the Rev. Sidney Vatcher; a Goshawk (*Astur palumbarius*) captured at sea, presented by Capt. F. Manley; an Egyptian Vulture (*Neophron percnopterus*) from Africa, presented by Mr. J. L. Teage; two —— Buntings (——) from North Africa, presented by Lord Lilford, F.Z.S.; eighteen Filfola Lizards (*Lacerta muralis* var. *filfolensis*) from the Island of Filfola, eighteen Wall Lizards (*Lacerta muralis* var. *tiliguerta*), an Ocellated Sand Skink (*Sepsocellatus*), a Moorish Gecko (*Tarentola mauritanica*), a Turkish Gecko (*Hemidactylus turcicus*) from Malta, presented by Capt. Robert A. Threshie; a Common Kite (*Milvus ictimus*) from Spain, received in exchange; five Dingos (*Canis dingo*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE NEW COMET.—The weather has prevented observations of the new Comet. Its brightness is about that of the nebula in Andromeda, and it has been suggested that it is a return of Biela's Comet.

COMET BROOKS (AUGUST 28).—The following is a continuation of the ephemeris of Comet Brooks for the present week, extracted from *Astronomische Nachrichten*, No. 312:—

12*h. Berlin M.T.*

1892.	R.A. app. h. m. s.	Decl. app. ° ′	Log *r*.	Log Δ.	Br.
Nov. 17...	10 25 3 ...	−2 35·2			
18...	29 40 ...	3 34·7			
19...	34 20 ...	4 34·8			
20...	39 3 ...	5 35·3 ...	0·0674 ...	9·9568 ...	20·51
21...	43 48 ...	6 36·2			
22...	48 36 ...	7 37·5			
23...	53 27 ...	8 39·0			
24...	10 58 20 ...	9 40·8 ...	0·0540 ...	9·9483 ..	22·70

The unit of brightness occurred on August 31.

The motion of this comet will be noticed from the above ephemeris to be very rapid in a southerly direction, amounting to about 1° per day.

THE LIGHT OF PLANETS.—The question as to whether the light of planets is capable of casting shadows must have, especially during the last few months, been in the minds of many, and perhaps many observations have already been made, but unfortunately not published. With regard to this question, *L'Astronomie* for November contains two notes, the first of which, communicated by M. Marcel Moye on August 30, relates to the planet Mars. His observations were made just before the meridian passage and in a room where the light of the planet could enter the open window. In this way white paper invisible in the corners of the room was easily distinguished when placed on the wall opposite the window, while one could see well the shadows between the fingers of the hand; placing a newspaper in the light of Mars only the place of the table and the number of the words could be recognized, but not read, as was the case with Jupiter. M. Moye concludes then that Mars certainly casts shadows, less strong than those of Jupiter but still appreciable.

In the note on the light of Venus M. Léon Guiot tells us that on August 29, when about to get up to observe Jupiter, he was astonished at the brilliancy of the light that entered his window. Observing his watch, which was hanging on the wall, he was actually able to trace its shadow on the wall, for he says that all was visible as in the light of the moon; one could even read the newspaper. It was about this time that Venus was constantly seen with the naked eye in full daylight.

STELLAR MAGNITUDES IN RELATION TO THE MILKY WAY.—Prof. Kapteyn is the author of an important memoir, which is published in the *Bulletin du Comité International Permanent* pour l'execution photographique de la carte du ciel, relative to an observed systematic difference between the photographic and visual magnitudes of stars depending on their distance from the Milky Way. Prof. Kapteyn first noticed that a difference existed in 1890, but in the present paper he presents a preliminary account of the results he has obtained. The clichés which have been under examination were exclusively those made at the Cape Observatory for the chart mentioned above. In this discussion he has adopted the two following laws: (1) that increasing the time of exposure in the proportion of 1 to 2·5, the fraction of a magnitude gained is 0·7, and (2) the atmospheric extinction of actinic rays rises to 2½ above the visual rays. Since there is an undoubted difference between the photographic and visual magnitudes, denoting this difference by the symbol Δm, the author commences to investigate whether this quantity is ever equal to zero, that is when the photographic and visual magnitudes are equal, and if so to find the locus of these points. Charting the points down on a map and connecting them up by means of curves, the latter are found to follow in a striking manner the path of the Milky Way. Table II. gives the values of Δm obtained from several clichés, and the positive values lie without exception between these two curves, while the negative ones are situated without. Taking into consideration both bright and faint stars, that is stars from the 4th to the 10th magnitude, the author finds that there a strong relation depending on their galalactic latitude exists between them, whether they be even very near or distant from the Milky Way, and the same systematic variation of Δm apparently holds good, being represented by the formula

$$\Delta m = \alpha + \kappa\beta$$

β representing the galalactic latitude and $\kappa = -0^m{\cdot}0099 \pm 0^m{\cdot}0010$.

In seeking for an explanation of the difference, Prof. Kapteyn investigates each possible cause singly. His conclusion, to state briefly, amounts to this, that, if one considers the stellar magnitudes given in the "Uranometrique" and in Gould's "Catalogue of Zones" (it is from these two sources that he has obtained the visual magnitudes) to be correct and not subject to systematic errors amounting sometimes to as much as half a magnitude, then it must be concluded that the light of the stars situated in the Milky Way or in its vicinity is much richer in actinic rays than those at considerable galalactic latitudes. We may remark that the publication of this paper has been purposely hurried owing to the importance of the matter therein, but although sufficient observations have not been taken in account for a very rigid investigation, Prof. Kapteyn hopes to eliminate many of the difficulties and accidental errors by the discussion of clichés of different regions of the sky, differing in galalactic latitudes, made at equal altitudes, on similar plates, with equal lengths of exposure.

THE CANALS OF MARS.—The late opposition of Mars, and the re-observation of the doubling of the canals has brought forward many theories relative to this very curious phenomenon. There seems to be no doubt now that this doubling is not due to instrumental deficiencies, or even to an optical delusion caused by the fatigue of the eyes; but that it is a real observed fact and therefore requires a rigid explanation. Omitting the now well-known hypotheses suggested up till quite lately, the most recent is that put forward by M. Norman Lockyer and which is recorded in NATURE, vol. xlvi. p. 448. Mr. Lebour also (NATURE, vol. xlvi. p. 611) points out the likeness of these markings to the cracks produced in glass broken by torsion, adding that the chief characteristic features in the Mars' lines are there produced. In *Comptes rendus* (No. 18) for October 31 M. Stanislas Meunier relates another possible cause, and illustrates the phenomenon experimentally. The experiment is as follows:—He takes a polished metallic surface and on it traces a series of lines and spots, representing as nearly as possible the Martial surface as seen by us, and illuminates it all by sunlight. He then stretches at some distance (a few millimetres) from it a fine transparent piece of muslin. Looking at the surface through this medium he finds that all the lines and spots are doubled, and, "se germiner par suite de l'apparition, à côté de chacune d'elles, de son ombre, dessinée sur la mousseline par la lumière que le métal a réfléchie." A fact observed by M. Schiaparelli is that the canals when doubled are not always exactly parallel, and that sometimes there is an "aspect de nébulosité." These and other peculiarities are, according to M. Meunier, reproduced by simply undulating the muslin. His explanation is that the solar light is reflected from the planet's surface very unequally, that from the continents exceeding that emitted by the deeper parts, seas and canals. Although the atmosphere is a limpid one, we are unable to see its motions; but if, as he says, the ærial envelope includes a transparent veil of fog at a suitable height, a contrast would be produced, as was the case with the muslin, by the production of shadows "qui pour une œil placé ailleurs que sur le prolongement des rayons réfléchis, à côté de chacune des surfaces peu réfléchissantes, une image pareille à elle." This explanation of the phenomena of shades by reflection if valid should of course hold good for the planet Venus when properly situated, and that it is not observed on the Moon is only another proof that our satellite has no atmosphere.

GEOGRAPHICAL NOTES.

THE *Revue Française* states that a subterranean town, laid out with regular streets in a series of great caverns, near Karki, on the right bank of the Amu-daria, has recently been explored. Pottery and metal work were found amongst the ruins, and from the coins and inscriptions seen the town must have been occupied at least as early as the second century B.C.

BY the new constitution of the United States of Brazil the seat of government is to be transferred from Rio de Janeiro to a site upon the central plateau where an area is to be marked off as a federal district. A scientific mission under Senor Cruls has been appointed to examine the region where the three rivers, Sao Francisco, Tocantins, and Parana, take their rise at an elevation of over 3,000 feet, with the view of finding a suitable site for the new capital.

MR. D. J. RANKIN communicates to the *Scottish Geographical Magazine* an account of his journey up the Zambesi in 1890-91, with a map of the country between the Zambesi and Shire. He found the Zambesi freely navigable for light-draught steamers as far as the Acababassa Falls, more than 300 miles from the sea, the Lupata narrows presenting no difficulty. Between Lupata and Acababassa extensive coal deposits occur, and these are sure to become valuable. Beyond the falls after a portage of about thirty miles, the Zambesi is again navigable

to Zumbo, and thence for a distance of 300 miles up the Loangwe river.

A NOMINATION to the geographical studentship of £100 in the University of Oxford will be made at the end of Hilary term, 1893. Particulars of the appointment may be obtained from Mr. Mackinder, the Reader in Geography.

Two sudden deaths of men known in connection with minor exploration and geographical writing are announced. Mr. Theodore Child, author of "South American Republics" and other works, died of cholera at Ispahan, and Lieutenant Frederick Schwatka, who has travelled extensively in Alaska, committed suicide in Portland, Oregon.

MR. PRATT, whose departure for the head-waters of the Amazon was announced in this column at the time, has been compelled to relinquish the expedition on account of ill-health, and is now in this country.

AT the first meeting of the Royal Geographical Society the certificates of 106 new members, including 15 ladies, were read. This is the largest number seeking admission into the society which has yet been proposed at one time.

DR. NANSEN'S ARCTIC EXPEDITION.

DR. FRIDTJOF NANSEN opened the session of the Royal Geographical Society on Monday night by a description of his plans for crossing the north polar region, and received a most enthusiastic reception from a crowded audience. His scheme involves two separate considerations: (1) the direction of the prevailing polar currents, and (2) the means by which these currents can be utilized for transporting an expedition. All attempts to reach the pole by Smith Sound, by the east coast of Greenland, and by the north of Spitzbergen have been complicated by contrary currents; the few expeditions by way of Bering Sea, although equally unsuccessful, have had the currents in their favour.

Taking into account all the available data, it appears that the polar current between Greenland and Spitzbergen carries southward between 80 and 120 cubic miles of water every twenty-four hours. The Gulf Stream drift may carry 60 or 70 cubic miles of water a day into the polar basin north of Nova Zembla, about 10 or 14 cubic miles daily probably flow in through Bering Strait, and possibly about one cubic mile a day of fresh water pours in on the average from the great Siberian rivers. This comparatively small addition of fresh water must account for the salinity of the Greenland outflowing current being somewhat less than the average salinity of the North Atlantic. Theoretically there would thus appear to be a current running from near the New Siberian Islands towards the north of Greenland.

The existence of such a current is strongly indicated by the drift of the *Jeannette* from 71° 30′ to 77° 15′ N. after being caught in the ice, this drift being northwestward from Bering Strait. Again, articles lost on the sinking of the *Jeannette* in the latter position off the New Siberian Islands were found on an ice-floe near Julianehaab, in the south of Greenland. A throwing-stick, of a kind made only by the Eskimo of Alaska, was found a few years ago near Godthaab, on the west of Greenland. Siberian driftwood is stranded regularly on the coasts of Greenland, and even on the north coast of Spitzbergen. These facts can only be accounted for by the theory of an ocean current across the polar basin. The evidence of the relative thickness of ice in different parts of the Arctic Sea, and of the occurrence of Siberian diatoms in the mud of ice-floes between Greenland and Iceland is strongly confirmatory.

Dr. Nansen intends to make the northwesterly current transport him across the middle of the polar basin, and so give him an opportunity for making scientific observations nearer the pole than has ever previously been done. He will sail next June *via* the Kara Sea for the New Siberian Islands, thence work a way as far north as possible; when stopped, he will run into the ice, and await the time when he will be drifted into the open sea again between Greenland and Spitzbergen. He has had a ship built in Norway expressly for the voyage. Her form is such as to cause the ice, on closing round, to lift her out of the water, and she will rest upright on its surface. This vessel, named the *Fram* (*i.e.* Forward), is built of very long-seasoned timber, and is more strongly put together than any other vessel of her size. The frame timbers are of great thickness, and set close together, so that if all the planking were stripped off the vessel would remain water-tight. The planking is first a ceiling of pitch pine, alternately 4 and 8 inches thick, then outside two layers of oak, 3 and 4 inches thick respectively, and over all is an "ice-sheathing" of from 3 to 6 inches of the hard and slippery greenheart. The sides are thus from 28 to 32 inches thick of solid wood. The decks are equally strong, and the cabins are planned so as to be isolated by store rooms and coal-bunkers from the sides, while non-conducting materials such as cork, felt, and reindeer hair are introduced between the walls or decks and the rooms to guard the crew from cold.

The vessel is sharp fore and aft, and both propeller and rudder may be lifted in wells so as to avoid risk of fouling the ice. The rudder is deeply immersed when in action, so that floating ice will not touch it. Both stem and stern overhang greatly, and are heavily plated with iron to crush and cut through thin ice. The length of keel is 101 feet, and the length of deck over all is 128, while the greatest beam (exclusive of ice sheathing) is 36 feet, and the depth 17 feet. These proportions are very unusual, but were adopted as the result of experience in other ships. With light cargo she will draw 12 feet, and fully loaded $15\frac{1}{2}$, the displacement being about 800 tons. She is rigged as a three-masted schooner, with square sails on the foremast, and has an engine of 160 indicated horse-power. The crow's nest on the maintopmast is 105 feet above the water-line, so as to give a wide horizon for the look-out. Two large decked boats are carried, in either of which the whole crew of twelve men could live if the ship were lost. Dogs, sledges, ski, several small boats, canvas for building extra boats on an emergency, and provisions for five or six years are taken. A pendulum apparatus is included in the scientific outfit, which is otherwise very complete. The ship is fitted with electric light; the dynamo may be worked by a windmill when coal can no longer be spared, or as a last resort it can be driven by a capstan arrangement adapted for four men, thus supplying healthy exercise and useful work to one-third of the crew, and abundant light to the remaining two-thirds.

The duration of the voyage cannot be estimated, as it will entirely depend on the rate of drifting, which must vary considerably from year to year, but judging from the movement of the *Jeannette* relics, two years ought to suffice.

A REMARKABLE CASE OF GEOMETRICAL ISOMERISM.

AN exceptionally interesting memoir is contributed to the current number of *Liebig's Annalen* by Prof. Wislicenus of Leipzig, who has latterly identified himself so earnestly with the subject of molecular configuration. It has been suspected for some years that there are two isomeric unsaturated acids of the composition $C_4H_7.COOH$. One of these substances exists in the free state in the roots of *Angelica archangelica* and has therefore received the name of *angelic acid*. The other compound is found along with angelic acid in Roman oil of cumin and has been termed *tiglic acid*. These two acids, moreover, behave so similarly in almost all their reactions with other substances that the conclusion has been rendered inevitable that they must be represented not only by the above formula, but by the same constitutional formula, $CH_3.CH : C\!\begin{array}{l}\diagup CH_3\\ \diagdown COOH\end{array}$. That the two acids are not identical, however, was indicated by certain slight differences of behaviour, and Prof. Wislicenus felt convinced that the two were in fact geometrical- or stereo-isomers, the difference consisting in a different arrangement of their various radicle groups in space. He considers it probable that the nature of the difference may be represented in one plane by the following formulæ:

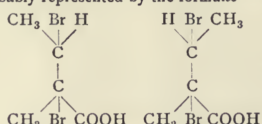
$$\begin{array}{c}CH_3-C-H\\ \|\\ CH_3-C-COOH\\ \text{Angelic acid.}\end{array} \text{ and } \begin{array}{c}H-C-CH_3\\ \|\\ CH_3-C-COOH.\\ \text{Tiglic acid.}\end{array}$$

Judging from previous experience of the behaviour of other geometrical isomers of a similar nature, it appeared probable that the halogen addition products of the two acids would exhibit differences so marked as to determine definitively the separate nature of the two acids. Under the direction of Prof. Wislicenus, therefore, one of his pupils, Herr Pückert, undertook the investi-

gation of the bromine addition products of angelic and tiglic acids, and was successful in showing that the two products were essentially different, exhibiting properties indeed so dissimilar that their identity was entirely out of the question. Although their similar constitution was indicated by melting-points differing by only one or two degrees, yet it was found that the crystals of the dibromide of angelic acid immediately reacted with water with production of a colourless oil, whilst the dibromide of tiglic acid remained unchanged in contact with water; moreover, the two compounds upon decomposition of their sodium salts, yielded two mono-brom-pseudo-butylenes, which differed essentially in their capability of reacting with alcoholic potash.

In the year 1890, however, Prof. Fittig, of Strassburg, who had previously investigated the subject in conjunction with Herr Pagenstecher, and had obtained *identical* bromine addition products from the two acids, published a paper in the *Annalen* in which he sought to show that the results of Herr Pückert were incorrect, and that the two substances were identical. Prof. Fittig has since requested Prof. Wislicenus to withdraw the work or substantiate it, and further charges Prof. Wislicenus with seeing facts through the veil of his theory. Unfortunately Prof. Wislicenus has been unable hitherto to meet the attack owing to domestic loss and serious illness, but at last he is able to publish the results of a really classical piece of work which he has carried through himself, and which not only demonstrates the truth of Herr Pückert's conclusions, but places the results beyond all criticism, and shows the singular cause of Prof. Fittig's inability to repeat them. It is indeed remarkable, but nevertheless true, that the fate of the theory of geometrical isomerism has actually been trembling in the balance owing to the different situation of the draught cupboards in the Leipzig and Strassburg laboratories. In the former laboratory they are placed *between* the windows, and in deep shadow; in the Strassburg laboratory they are *against* the windows, and are consequently brightly illuminated in daylight. Now Prof. Wislicenus shows that the dibromide of angelic acid is only formed in the absence of bright light, *rays of daylight intensity being absolutely fatal to its formation.* Hence Prof. Fittig only obtained the relatively more stable dibromide of tiglic acid, which in a good light is yielded by both angelic and tiglic acids. As the case is so remarkable, it may perhaps not be uninteresting to give a brief summary of the work of Prof. Wislicenus.

During the course of other researches concerning geometrical isomers, it was found that in order to obtain addition-products in which no internal re-arrangement of atoms had occurred, it was necessary to observe three conditions. One must operate at the lowest possible temperature, exclude light as much as possible, and take care that the halogen to be added is always present in tolerably large excess. When these three conditions are observed, the two respective and distinct bromine addition-products of angelic and tiglic acids are always obtained. They are probably represented by the formulæ—



Dibromide of angelic acid. Dibromide of tiglic acid.

The operation of preparation is best conducted as follows:—A quantity of bromine, at least half as much again as is required by theory, and dissolved in three times its weight of carbon bisulphide, is placed in a flask surrounded by iced water. The flask is fitted with a triply bored caoutchouc stopper, through one hole of which is inserted a thermometer, through a second an exit tube furnished with a calcium chloride drying tube, and through the third the end of a burette containing a solution of pure angelic or tiglic acid in five times its weight of carbon bisulphide. The draught cupboard is darkened as much as possible and then the acid solution is slowly allowed to run into the flask. After the expiration of a few hours the formation of the brominated compound is complete, and the carbon bisulphide may be evaporated away in a rapid stream of dry air.

The difference between the two compounds is apparent even at this early stage, for the tiglic compound commences to crystallize long before the removal of all the carbon bisulphide, and soon forms a snow-white mass of crystals. On the contrary, the angelic dibromide shows no sign of crystallization, remaining as an oil for some time after the removal of all the carbon bisulphide. Eventually it crystallizes to a hard yellowish mass. The only solvent from which it was found practicable to recrystallize the angelic dibromide was the pentane fraction of petroleum ether boiling at 33°–39°.

The melting-point of pure angelic dibromide is 86·5–87. That of tiglic dibromide is 87·5–88. The two substances behave quite differently upon resolidification. The former congeals to a transparent resinous mass, whilst the latter forms an opaque solid.

The most striking difference is apparent in their respective behaviour towards water. The dibromide of tiglic acid is only slightly soluble in water, and dissolves unchanged, crystallizing out again upon evaporation. The dibromide of angelic acid, however, instantly combines with the equivalent of one molecule of water, to form a curious unstable liquid, an oil of high refractive power, which is somewhat soluble in excess of water, and is again deposited upon evaporation. This liquid compound is also formed when the dibromide is exposed to moist air, while the dibromide of tiglic acid is not changed in a moist atmosphere. In dry air the angelic liquid compound again dissociates into the dibromide and water vapour. In fact the dibromide of angelic acid would appear to act as an excellent indicator of the hygroscopic state of the atmosphere.

The two dibromides show a further difference in solubility, the angelic compound being far more readily soluble in all the solvents experimented with.

Finally the crystals of the two compounds, although both belonging to the triclinic system, are absolutely unlike. From measurements made by Dr. Fock, they are shown to exhibit different forms, entirely different angles, and different disposition of optic axes.

From the above description it will be quite evident that the two compounds are certainly not identical.

In conclusion, Prof. Wislicenus gives the results of attempts to obtain the dibromide of angelic acid in bright sunshine in the open air, then when working in front of a window, and again when the experiment was performed upon a table in the centre of the laboratory. In the first case, instead of the angelic compound, 92·8 per cent. of the dibromide of tiglic acid was obtained, in the second case 89·6, and in the third case 88·7 per cent. These results render it perfectly clear why Prof. Fittig could not obtain the angelic compound in his experiments, and they also show how it is possible for two chemists, both working with a desire to ascertain the truth, occasionally to obtain results apparently at complete variance with each other.

A. E. TUTTON.

MARINE LABORATORIES IN THE UNITED STATES.[1]

ONLY in comparatively recent times has the tremendous importance of the bearing of the invertebrates upon the general questions of biology been appreciated. We have seen that some work was done upon these animals at an early date, when the minds of workers were not much troubled by theoretical considerations, but the study of the adult forms is so small a part of a real understanding of these animals that it was unsatisfactory work, and never became popular among investigators until embryological methods had been introduced.

Dr. Brooks has remarked that "nearly every one of the great generalizations of morphology is based upon the study of marine animals, and most of the problems which are now awaiting a solution must be answered in the same way."[2] We find the reason for this in the fact that the biology of the present day is a study of vital phenomena and of natural laws governing living things. The importance of the invertebrates depends, therefore, upon the fact that in them life exists under simplified conditions, affording opportunities for the study of questions for which higher forms are, with our present knowledge, too complex.

As the study of invertebrates has extended, it has become more and more desirable to have more favourable conditions for this work, more abundant facilities for collecting and oppor-

[1] Reprinted from "Biological Teaching in the Colleges of the United States," by John P. Campbell, Professor of Biology in the University of Georgia; issued by the U.S. Bureau of Education.

[2] Johns Hopkins University Circulars, vol. vi., p. 37.

tunities for studying animals alive. Much of the early work was done upon specimens collected and stored in museums, but workers, both in this country and Europe, had frequently made excursions to the seacoast for the purpose of studying the invertebrate forms constituting so large a part of the marine fauna.

The unsatisfactory nature of this work was of course evident. Suitable accommodations and working appliances could not be provided under these circumstances, and desirableness of establishing permanent seaside laboratories was early felt. Nothing was done, however, in this country until 1871, when John Anderson, a wealthy citizen of New York, presented to Prof. Agassiz the island of Penikese in Buzzard's Bay, together with the sum of $50,000 with which to found a seaside station for the study of marine life. Another friend gave him a yacht of 80 tons burden for use in collecting. Agassiz had long wished for such a laboratory, and no one but himself could have aroused the necessary enthusiasm for carrying out the project. He soon set to work and built large aboratories, with suitable accommodations for a large number of workers. In 1873 they were opened for work. This constituted the first opportunity enjoyed by American students of studying marine animals in their native waters, with proper appliances for work. It inaugurated a new era in scientific research, being the first outward expression of an idea which has since taken a firm hold upon the investigators of the country. The death of Agassiz in December, 1873, put an end to the project. The buildings were used but two seasons and then abandoned.

Of this laboratory Prof. Whitman says:—

"At the close of the second and last season at Penikese, in 1874, Alexander Agassiz appealed to the colleges and all interested boards of education for support; but all in vain, for not a single favourable reply was received, and so his intention to remove the laboratory to Wood's Holl was never carried out. Thus that great and memorable undertaking, after absorbing money enough to build and equip a most magnificent laboratory, was abandoned from lack of interest on the part of educational institutions rather than of means. Such a failure, it must be frankly confessed, is not one to inspire confidence, but its explanation removes the apparent grounds for discouragement. It was the marvellous personality of Prof. Agassiz that made Penikese a possibility. It was his magic influence that created that school, his commanding individuality that organized and vitalized it. All interests centred in him so completely that with his sudden removal the enterprise was left without a soul. The school had no coherency except in his magnetic power and intellectual strength, and the moment these elements of stability were withdrawn, collapse followed as a natural and inevitable consequence. Then, too, it should be remembered that Prof. Agassiz lived just long enough to demonstrate the impracticability of maintaining such a school in such a locality, but unfortunately not long enough to convince the scientific world of its utility. The school was an experiment; its master was stricken down before it could be fairly tested, and the times were not ripe for it."

The establishment of this laboratory was an event of the greatest significance because of its bearings upon the history of education. Not only was Penikese the first biological station established in this country, and, indeed, in the world, but it was the beginning of the summer-school movement which has spread so generally over the country, and which, it should be noted, began with original research and finally extended to include the work of elementary instruction.

The movement met with the cordial support of naturalists everywhere, and was almost immediately followed by the establishment of Dohrn's magnificent station at Naples. Soon after, in 1875, a seaside station was established at Helder by the Netherlands Zoological Society, and other smaller ventures followed in Europe.

The need of opportunities for seaside study in the United States was too generally felt by those who had come under Agassiz's influence for the project to be allowed to stop. The advantages of this method of work over museum study had impressed themselves at least upon a few workers, and accordingly we find several attempts made to found new laboratories. They differed in character and aims, but all agreed in being founded upon the one idea of studying marine animals in their native waters.

The most direct successor of the Penikese laboratory is the private laboratory of Prof. Alexander Agassiz at Newport. While this building is constructed on a much smaller scale than that at Penikese and is open only to a limited number of workers, yet it is prominent for the elegance of its appointments and its conveniences for work.

The first laboratory for seaside study established in this country after the abandonment of Penikese was maintained by the Peabody Academy of Sciences, under the guidance of Prof. Packard, with the co-operation of Prof. Kingsley and others. This laboratory was for elementary instruction rather than research, and remained in existence only from 1876 to 1881.

In 1878 the trustees of the Johns Hopkins University made an appropriation to allow a party of workers to spend some time in seaside study. The party was under the guidance of Dr. W. K. Brooks, who had himself been a pupil of Agassiz and a member of the Penikese laboratory. The location selected was at the lower part of the Chesapeake Bay, from which the name of Chesapeake Zoological Laboratory was chosen. No permanent buildings were erected, as it was intended, if possible, to change the location from year to year; but an outfit of boats and collecting apparatus was provided. The summers of 1878 and 1879 were spent about the lower part of Chesapeake Bay at Crisfield, Md., and Fort Wool, Va., at which places special attention was given to the development of the oyster.

At the opening of the third season, in 1880, the need was felt of a locality that would offer a greater variety of objects for study, and accordingly the summers of 1880–82 were spent at Beaufort, N.C. This locality proved especially favourable, since sand bars, mud flats, salt marshes, and land-locked salt water, within easy reach, gave a large variety of different rare forms, and there was also abundant ocean dredging. A sufficient appropriation was made in 1880 to purchase a steam launch and a sloop, which put the workers in a position to take every advantage of their opportunities.

In 1883 a special study of oyster beds made a return to the mouth of the Chesapeake Bay necessary, and that season was spent at Hampton, Va., but the following two seasons were again spent at Beaufort.

In 1886 the need of a more southern location was felt, and the Bahama Islands seemed to offer an inviting field. The summer of 1886 was therefore spent at Green Turtle Cay, and the following summer at Nassau, New Providence.

Financial difficulties temporarily stopped the work of the laboratory, but it is announced that it will be reopened in the summer of 1891.[1]

It is difficult to summarize the work of this laboratory, and none the less so to over-estimate its importance. It enjoys the distinction of being the first marine laboratory ever carried successfully into operation in the United States, and its work was entirely original research. The character of work done differed from year to year, according to the facilities which the different localities offered; but in general it may be said that embryology received most attention, while considerably less was devoted to the discovery and description of new species. The methods employed, as well as the new facilities enjoyed, made it possible to apply effective means of solution to many problems previously obscure, as well as opening many questions in regard to which nothing had been done.

Of the lasting value of the work it is perhaps too early to speak, but the fact that over one hundred papers, based upon work there performed, have readily found publication in the best journals of this country and Europe, as well as the fact that much of the work has already found its way into standard text-books, gives strong testimony to its value.

The Chesapeake Zoological Laboratory may be regarded as the successor of the Penikese laboratory to the extent that its aims are the same, but it differed in not being generally open to the workers of the country. Arrangements were not made for large numbers, and those who were present were mainly students of the Johns Hopkins University. During the nine years that this laboratory remained in existence, there were in all fifty investigators present, and the average length of each session was nearly two months.

The need was felt, especially in that portion of the country where Agassiz's influence was more directly exerted, of establishing a laboratory on a larger scale, and open to a larger

[1] Shortly after the above was written, Kingston, Jamaica, was chosen as a suitable locality, and a party of advanced workers, numbering about fourteen in all, were present from May until September.—September 21, 1891.

number of workers, and the first step taken in this direction was the founding of a laboratory by the Boston Society of Natural History. In their report for 1881 these words occur:

"It has been considered desirable to found a summer laboratory sufficient to supply the needs of a class of persons who have begun to work practically under our direction, but have hitherto had no convenient means for pursuing their studies on the seashore. . . . . We are sure that such a laboratory is needed for a limited number of persons, such as our own pupils in natural history, and some of the teachers of the Boston public schools, about a dozen in all, but we are not sure of any real demand outside of these."

Arrangements for laboratory work were speedily made at Annisquam, Mass. Boats and appliances for collecting were at once provided, and in the spring of 1881 a circular was issued announcing the opening of the new laboratory. From this the following extracts are taken :—

"The liberality and co operation of the Woman's Educational Association enable the Boston Society of Natural History to announce that a seaside laboratory, under the direction of the curator (Prof. Alpheus Hyatt), and capable of accommodating a limited number of students, will be open at Annisquam, Mass., from June 5 to September 15.

"The purpose of this laboratory is to afford opportunities for the study and observation of the development, anatomy, and habits of common types of marine animals, under suitable direction and advice. There will, therefore, be no attempt during the coming summer to give any stated course of instruction or lectures.

"It is believed that such a laboratory will meet the wants of a number of students, teachers, and others who have already made a beginning in the study of natural history."

Twenty-two persons were attracted to the Annisquam laborat ry during its first season. Prof. Hyatt, in his report for 1882, remarks as follows :—

"The great need of an institution for teaching field work cannot be properly estimated by the number of those who are attracted by the opening of such opportunities for study. The mental condition of those who attend, and what it has done for them, and the sphere of influence which it reaches through them, are the only true standards by which its present and future usefulness can be properly measured. Nearly all the pupils were persons who could be termed 'well educated;' nevertheless they were, with the exception of some who had already worked in the laboratory or field, entirely unable to obtain knowledge with their own eyes and hands, and had even acquired a notion that this was not possible for anybody except the trained man of science. Several of these teachers, after their work was finished, expressed their gratefulness for the new powers the course had developed in themselves, and the fascinating pleasure they had experienced in learning to use their own eyes and hands in the study of things hitherto unapproachable for their uncultivated senses except through the deceptive mediation of books. When it is remembered that these teachers influence and mould the minds of thousands of young persons it is at the same time proved that what this laboratory has done and can do is not to be estimated by the nnmber of its own pupils."

The success of the undertaking seemed assured, and arrangements were made for its continuance during the five years following. The number of students fluctuated greatly, falling to ten in the third year, and running up in the sixth year to twenty-six.

During these six years the laboratory was carried on jointly by the Boston Society of Natural History and the Woman's Educational Association of Boston. It has been the policy of both of these associations to originate new enterprises, but to turn them over when well started into other hands. It seemed in 1887 that the time had come when the maintenance of the laboratory should be put on a firmer basis. It had been supported long enough to demonstrate its practicability and usefulness. The demands upon it had increased. It was no longer an experiment. The associations believed that a permanent organization should be effected, the working facilities increased, and the whole established on a larger scale. Moreover, it seemed that something more might be done to give the laboratory a wider sphere of usefulness in advancing knowledge of marine like. Great as was its work in teaching, it seemed to depend for its support upon a circle of people too small for the extent of its benefits. It seemed desirable that a change should come which would lead to a more widespread interest in the laboratory, and bring together more investigators. The Marine Biological Laboratory was the result of this movement.

While space will permit but a brief account of this laboratory, its history, development, aims, &c., it may be said that the one point which distinguished it from the Annisquam laboratory was the prominence given to research. Students are received, but from the outset there has been a settled determination to so adjust the claims of each as to secure the greatest amount of efficiency and do most to advance science. The organization was therefore effected so as to secure a permanent staff of investigators, who would always be present, increasing knowledge by their own work, and by their example stimulating others to follow. Moreover, the principle was thoroughly recognized that the best investigation is prompted by the work of teaching. The best investigator is often the best teacher, but the work of teaching reacts upon the work of investigation, influencing it for the better.

The experience of the laboratory shows that these points, which had previously been carefully considered, were well taken. Various means were resorted to for providing funds, and in March, 1888, the laboratory was incorporated.

Wood's Holl was chosen as a locality because of its convenience, accessibility, and the variety of its land and marine flora and fauna. The building was at once begun, and finished in time for work during the summer. Circulars could not be issued until after most of the colleges had disbanded for the summer, and yet during the first season seven investigators and eight students were attracted to the laboratory.

In subsequent years the growth has been a steady one. The number of workers has greatly increased, and even now, when only its third season has been passed, it is stated that the space is insufficient to meet the demands upon it; the facilities for collecting are too small, and the staff of instructors is not large enough for their classes. Its usefulness is now established, and the time is ripe for it. To it in great measure the United States must look for the advancement of biology. Let us hope that its trustees, all of whom are working biologists, may be successful in placing the laboratory upon such a financial basis that its full possibilities for usefulness may be realized.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. Hill, Master of Downing College, has been appointed Chairman of the Natural Science Tripos Examiners for 1893. An election to an Isaac Newton Studentship in Astronomy, Astronomical Physics, and Physical Optics, will be held in the Lent term 1893. Candidates must be B.A.'s, and under twenty-five years of age on January 1. The emoluments are £200 per annum for three years. Applications are to be addressed to the Vice-Chancellor between January 17 and 27, with testimonials or other evidence of competency.

Dr. Lorrain-Smith, M.D. Edin., Demonstrator of Physiology at Oxford, and Dr. F F. Wesbrook, M D., Manitoba, Professor of Pathology at Winnipeg, have been elected John Lucas Walker Students in Pathology. The Managers express their high approval of the valuable researches conducted by the late student, Dr. A. A. Kanthack, of St. John's College. The State Medicine Syndicate state that, at the two examinations held in April and October, 1892, there were in all sixty-four candidates, of whom thirty-five received Diplomas in Public Health. The fee in future will be five guineas for each of the two parts of the examination in State Medicine.

Examinations for open scholarships and exhibitions in Natural Science will be held in twelve of the Colleges in December and January next. A list giving the conditions and value of the scholarships is published in the *University Reporter* of November 12, pp. 198, 199.

SCIENTIFIC SERIALS.

Wiedemann's Annalen der Physik und Chemie, No. 10.—Refraction and dispersion of light in metal prisms, by D. Shea. Thin prisms of gold, silver, nickel, and cobalt were prepared by the electrolysis of cyanide solutions by Kundt's method. Prisms of platinum were also prepared by the disintegration of platinum foil. A piece of foil 4 mm. broad and 0·02 mm. thick placed perpendicularly to a piece of plate glass at a distance of 0·5 mm. produced under the action of a current of 20 amperes a double wedge-shaped layer of oxide in half an hour.

This was easily reduced by a Bunsen flame, so as to represent a metallic prism with an angle of some 20 seconds. Only one in twenty of the prisms could be used, and only one in 200 silver or gold prisms. The source of light was a zirconium burner with a red shade transmitting light of the mean wave-length $64 \times 10^{-}$ cm. The index of refraction was found to vary with the incidence. For perpendicular incidence the following values were found: Au 0·26, Ag 0·35, Cu 0·48, Pt 1·99, Ni 2·01, Iron 3·02, Co 3·16. For silver the index was 0·39 at an incidence of 10°, 0·60 at 30°, 0·80 at 50°, 1·01 at 80°, and 1·03 at 90°. The following refractive indices for various wave-lengths illustrate the dispersion:

	Li, α	D	F	G
Au	0·29	0·66	0·82	0·93
Ag	0·25	0·27	0·20	0·27
Cu	0·35	0·60	1·12	1·13
Pt	2·02	1·76	1·63	1·41

—On a law of refraction for the entrance of light into absorptive media, by H. E. J. G. du Bois and H. Rubens.—On the infra-red emission spectra of the alkalies, by Benjamin W. Snow.—Absolute change of phase in light by reflection, by Paul Glan.—Inductive representation of the theory of double refraction, by Franz Koláček.—Studies in the electric theory of light, by D. A. Goldhammer.—On the passage of feeble currents through electrolyte cells, by Rud. Lohnstein.—On the motion of the lines of force in the electro-magnetic field, by Willy Wien.—On the electric theory of magneto-optic phenomena, by D. A. Goldhammer.—An automatic interruptor for accumulators, by H. Ebert. This is to prevent the current from the accumulator exceeding the supply for which it is constructed. Two mercury cups are inserted in the circuit, connected by a piece of stout copper wire. The current next passes through an electro-magnet. As soon as the current reaches a certain strength the electro magnet overpowers an adjustable spring, and lifts the copper connecting-piece out of the cups.—Contribution to the history of the spheroidal phenomena, by G. Berthold.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, October 28.—Dr. J. H. Gladstone, F.R.S., past president, in the chair.—The discussion on Mr. Williams's paper, "On the relation of the Dimensions of Physical Quantities to Directions in Space," was opened by Prof. Perry reading a communication from Prof. Fitzgerald, president. The writer said Mr. Williams disagreed with the suggestion that electric and magnetic inductive capacity are quantities of the same kind principally because he had not got over the curious prejudice that potential and kinetic energy are different. No theory of the ether could be complete unless it reduced its energy to the kinetic form. Electric and magnetic inductive capacity would probably be found to be similar in the ether, and ultimately have the same dimensions. The analogies were not yet complete, but only in respect of *matter* was it probable that any difference existed between them. Diamagnetism corresponded to electrostatic induction, but paramagnetism had no definite electrical analogue. He was inclined to regard the phenomena of paramagnetism as connected with the arrangement of the material molecules, whilst diamagnetism depended on the electric charges on those molecules. So far no matter had been found which conducts magnetism, and such may not exist in our universe, but it may be gravitationally repelled by matter as we know it.—Mr. Madan remarked that in the first part of his paper Mr. Williams recognized that dimensional formulæ were originally change-ratios, but puts this aside for the higher conception which regards the e formulæ as expressing the nature of the quantity. Fourier showed how to find the dimensions of units by making the size of the fundamental units vary. But k (specific inductive capacity) did not vary with the fundamental units, for it was merely the ratio of the capacities of two condensers, and therefore, by Mr. Williams's definition, a pure number. It was difficult, he said, to see how k could have dimensions, but Mr. Williams regarded it as a physical quantity, and therefore possessing dimensions. The object in giving dimensions to k and μ seemed to be to get over the double system of units. Mr. Madan did not think that dimensions could express the nature of physical quantities, and said differences of opinion existed amongst authorities on this point. For example, Dr. J. Hopkinson, at the last B.A. meeting, said that because a co-efficient of self-induction had the dimensions of length it must be a length, whilst other learned professors objected to this view. Even if one admitted that dimensions are a test of the nature of physical quantities it was not necessary that the two systems of units should be identical. The connecting link between the two systems was $Q = C\,t$, and the validity of this equation had been questioned. If this objection be confirmed, then there would be no current in electrostatics and no Q in the electromagnetic system, and the units would not clash. Referring to dynamical units, Mr. Madan pointed out that two units of mass were used in astronomy, but astronomers got over the difficulty by using a co-efficient. Dimensional formulæ, he said, are the result of a convention that certain definitions should hold true generally, but they contain no further information respecting the nature of the quantities beyond that involved in those definitions. As an example of the inability of such formulæ to express the nature of quantities, he pointed out that whilst physical differences were known to exist between + and − electricity the dimensional formulæ showed so signs of such differences.—Prof. Rücker said every correct physical equation consisted of a numerical relation between physical quantities of the same kind, and might be written either as a mere numerical equation or as a relation between the physical quantities themselves. The equation $2 + 1 = 3$ may correspond to 2 feet + 1 foot = 3 feet, and the latter may be written $2[L] + 1[L] = 3[L]$, where [L] represents the unit of length. So far as he was aware, nobody but a recent writer in the *Electrician* had denied that in such an equation [L] represented a concrete quantity. Maxwell explicitly stated that it does in his article on "Dimensions" ("Encyl. Britt.") and elsewhere, and Prof. J. Thomson, in his paper on the same subject, makes no statement contrary to this. The above equation might also be written 2[feet] + 1[foot] = 1[yard]. Another equation involving time is 60[sec.] = 1[minute], and dividing one by the other one gets

$$\tfrac{2}{60}\left[\frac{\text{foot}}{\text{sec.}}\right] + \tfrac{1}{60}\left[\frac{\text{foot}}{\text{sec.}}\right] = 1\left[\frac{\text{yard}}{\text{min.}}\right].$$

A difficulty was felt here in understanding what dividing a foot by a second meant; but this difficulty Prof. Rücker considered was not greater than that involved in dividing an impossible by a real quantity, a very familiar analytical device. Reasons for regarding the symbols $\left[\frac{\text{foot}}{\text{sec}}\right]$ as legitimate were then given. Prof. Henrici said the communication under discussion was one of the most important contributions to physical science which he had come across for a long time. Such difficulties as presented themselves in the paper arose from its fundamental character. The author had attempted to express all physical quantities in terms of three, but quantities may exist which cannot be completely represented in terms of L, M and T. The tendency of modern mathematics was to express everything dynamically. Mathematicians had long been in the habit of using quantities which were neither numbers nor concretes in the ordinary sense, and different kinds of algebra with units not understandable had been developed. If a quantity, a times a unit u, be multiplied by b times another unit v, the result is expressed by $ab\,uv$, where ab is a number and uv a new unit which may or may not be physically interpretable. The interpretation of a product depended on the meaning attached to "multiplication," and if this be restricted to "repeated addition" the range is very limited. The narrow conceptions concerning multiplication acquired at school could only be removed by a careful study of vectors. Mr. Williams had treated his subject by vector methods, but a few traces of quaternions remained which might be omitted. To truly understand the subject, vectors must be treated vectorially. Dimensions might then show the nature of the quantities involved. The system adopted in Mr. Williams's paper was probably the best attainable at present, but he (Prof. Henrici) looked forward to the use of a more fundamental quantity than the vector—viz. "the point"—as the ultimate basis. Grassmann had worked out a "point calculus" in 1844, which was republished in 1880. Quantities more complex than vectors, viz. rotors, screws, motors, &c., had been used with advantage by Clifford, Ball, and others. Dr. Sumpner thought the first ideas of students on the subject of dimensions were that they represented the nature of the quantities, but could not see why every quantity should be expressed in terms of L, M and T. Prof. Rücker's paper on "Suppressed Dimensions" had cleared up several important points, and he (Dr. Sumpner) now considered that every quantity

must be expressed in terms of a unit of the same kind as itself. He viewed Mr. Williams's attempt to express everything in terms of L, M and T, as rather a retrograde step. The discussion on Mr. Williams's paper was adjourned, and Dr. Young made some remarks on Mr. Sutherland's communication "On the Laws of Molecular Force." Mr. Sutherland, he said, thought that Ramsay and Young's law $\partial p/\partial T = f(v)$ is not correct for compounds in the liquid state. Barus, however, had proved that several liquids, including ether, only showed variations from the law at extremely high pressures. After writing the equation of the virial in the form $pv = RTvf(v) + v\phi(v)$, where $v\phi(v)$ stands for the internal virial term; the author of the paper had shown that $v^2\phi(v)$ ought to be constant, but, finding it not constant in the case of ether, &c., he attempted to explain the discrepancies by the formation of pairs of molecules at small volumes. Other substances, such as nitrogen and methane, were supposed to follow the law. This, Dr. Young said, could not be accepted as proved, for the range of volumes over which the experiments had been made was only small, and methane was difficult to prepare pure. After criticizing the use of two and sometimes three "characteristic equations" for the same substance, he went on to show that the formulæ given in the paper by which the critical temperatures, pressures and volumes might be calculated, lead to results differing from experimental numbers by quantities greatly in excess of experimental errors. Experiment also showed that capillarity had little or no effect on the determination of critical constants. Speaking of critical volumes he pointed out that MM. Cailletet and Mathias had published a method of finding critical densities which gave very accurate results. Mr. Sutherland's conclusions respecting Van der Waals's generalizations were practically identical with those expressed by Dr. Young in his paper on the subject, read before the Society last year. The views as to the nature of the various kinds of "pairing" mentioned in Mr. Sutherland's paper were open to serious objections, for his "physical pairing" is supposed to produce more effect on the "characteristic equation" than true chemical pairing. In his (Dr. Young's) opinion the idea of physical pairing appears somewhat speculative and requires further elucidation.—A paper on the determination of the critical density, by Dr. Young and Mr. A. L. Thomas, and two papers, on the determination of the critical volume, and on the boiling points of different liquids at equal pressures, by Dr. Young, were taken as read. The first paper gives an account of results obtained by Cailletet and Mathias's method, based on the fact that the means of the densities of a substance in the states of liquid and saturated vapour when plotted with temperature, lie on a straight line which passes through the critical point. In the paper on critical volumes the above-mentioned method is again referred to and results obtained thereby accepted in preference to those given by the author in his paper on Generalizations of Van der Waals, &c., read before the Society about a year ago. The alcohols do not strictly follow the straight-line law. Revised tables of critical volumes, densities, pressures, and temperatures are given, and it is pointed out that for many substances the ratio of the actual critical density to the theoretical density (for a perfect gas) is about 3·8. The paper on boiling-points of different liquids at equal pressures contains a comparison of the accuracies with which a formula for the relation between the boiling-points given by M. Colst (*Compt. Rend.*, cxiv. p. 653), and one by Ramsay and Young (*Phil. Mag.*, January 1886), accord with experimental results. The author concludes that the latter formula shows the best agreement, but that of M. Colst is satisfactory under certain conditions. The further discussions of Mr. Williams's and Mr. Sutherland's papers were adjourned till the next meeting.

Mineralogical Society, October 25.—At the Anniversary Meeting the following were elected Officers and Members of Council:—President, Prof. N. S. Maskelyne, F.R.S.; Vice-Presidents, Rev. Prof. S. Haughton and Dr. Hugo Müller, F.R.S.; Treasurer, Mr. F. W. Rudler, F.G.S.; General Secretary, L. Fletcher, F.R.S.; Foreign Secretary, Mr. T. Davies; Ordinary Members of Council, Prof. A. H. Church, F.R.S., Prof. Grenville A. J. Cole, Mr. T. W. Danby, Dr. C. Le Neve Foster, F.R.S., the Rev. H. P. Gurney, Mr. J. Horne, Prof. J. W. Judd, F.R.S., Prof. G. D. Liveing, F.R.S., Lieut.-General C. A. McMahon, Mr. H. A. Miers, Mr. F. Rutley, and Mr. J. J. H. Teall, F.R.S.—Dr. C. O. Trechmann detailed the results of the goniometrical measurement of two very perfect crystals of Binnite collected by himself in the Binnenthal. The measurements, besides adding a large number of forms to those previously recorded for this species, serve to establish the tetrahedral hemisymmetry of the mineral which has been left as a very doubtful feature by previous observers, and was denied by Hessenberg.—Mr. H. A. Miers and Mr. G. T. Prior announced the results of further researches on the rare silver minerals known as Xanthoconite and Rittingerite. According to their physical measurements and chemical analyses these two substances are identical, both having the same composition as Proustite, and crystallizing in rhombic-shaped tables belonging to the mono-symmetric system. The name Xanthoconite, given by Breithaupt, has the priority; the red-silver ores are now to be regarded as an isodimorphous (?) group consisting of the two sulph-arsenites Proustite and Xanthoconite, and the two sulph-antimonites Pyrargyrite and Fireblende. Previous determinations of the composition of Rittingerite and the crystalline form of Xanthoconite have been erroneous.—Mr. Fletcher gave a description of a new habit of Descloizite from the Argentine, and also an account of the new mineral Baddeleyite (native zirconia): the only fragment as yet found is part of a twinned crystal showing forms which belong to the mono-symmetric system: pleochroic: optically negative and biaxal with inclined dispersion: specific gravity 6·025: hardness 6·5.—Mr. Allan Dick contributed further remarks on Geikielite, supplementing his paper read at the previous meeting.—Prof. Judd exhibited photographs in illustration of his previous paper on the lamellar structure of quartz crystals and the method by which it is developed.—Mr. Rutley exhibited a large series of beautiful cardboard models illustrative of the symmetry and optical characters of the crystalline systems.—Mr. Miers exhibited specimens, including the rare mineral Turnerite from the Tintagel Slate quarries which he had visited in search of that mineral.

Zoological Society, November 1.—Sir W. H. Flower, F.R.S., President, in the chair.—The Secretary read a report on the additions that had been made to the Society's Menagerie during the months of June, July, August, and September, 1892, and called special attention to a young Gibbon from Hainan, South China, of a uniform black colour, belonging to the species recently described by Mr. Oldfield Thomas as *Hylobates hainanus*, presented by Mr. Julius Neumann, and to a young male Malayan Tapir (*Tapirus indicus*) from Tavoy, Burmah, presented by Col. F. M. Jenkins.—Mr. E. Hartert exhibited (on behalf of the Hon. Walter Rothschild) examples of two new Mammals from New Guinea (*Proechidna nigroaculeata* and *Acrobates pulchellus*), and a stuffed specimen of *Apteryx maxima* from Stewart Island.—A communication was read from Lord Lilford, giving an account of the breeding of a pair of Demidoff's Galagos in his possession.—Prof. Bell read a note on the occurrence of *Bipalium kewense* in Ireland.—Mr. Finn gave an account of his recent zoological excursion to Zanzibar.—Prof. Newton, F.R.S., exhibited and made remarks on a specimen of *Sylvia nisoria* lately killed in England.—Prof. F. Jeffrey Bell read a description of a remarkable new species of Echinoderm of the genus *Cidaris* from Mauritius, proposed to be called *C. curvatispinis*.—A communication was read from Sir Edward Newton, and Dr. Gadow, F.R.S., describing a collection of bones of the Dodo, and other extinct birds of Mauritius, which, having been recovered from the Mare aux Songes in that island by the exertions of Mr. Theodore Sauzier, had been by him entrusted to them for determination. The collection contained examples of the atlas, metacarpals, prepelvic vertebra, and complete pubic bones of the Dodo, which had before been wanting, as well as additional remains of *Lophopsittacus*, *Aphanapteryx*, and other forms already known to have inhabited Mauritius. Besides these there were bones of other birds, the existence of which had not been suspected, and among them of the following, now described as new:—*Strix* (?) *sauzieri*, *Astur alphonsi*, *Butorides mauritianus*, *Plotus nanus*, *Sarcidiornis mauritianus* and *Anas theodori*, the whole adding materially to the knowledge of the original fauna of Mauritius.—Mr. Oldfield Thomas gave an account of a collection of Mammals from Nyassa-land, transmitted by Mr. H. H. Johnston, under whose directions they had been obtained by Mr. Alexander Whyte.—Dr. Günther, F.R.S., read a paper descriptive of a collection of reptiles and Batrachians from Nyassa-land, likewise transmitted by Mr. Johnston, and containing examples of several remarkable new species, amongst which were three new Chameleons, proposed to be called

Chamæleon isabellinus, *Rhampholeon platyceps*, and *R. brachyurus*.—Mr. R. Lydekker read a memoir on some Zeuglodont, and other Cetacean remains from the Tertiaries of the Caucasus.—Mr. Martin Jacoby read the descriptions of some new genera and new species of Phytophagous Coleoptera from Madagascar.

Linnean Society, November 3.—Prof. Stewart, President, in the chair.—The Rev. Prof. Henslow exhibited an instrument used in Egypt for removing the end of the sycamore fig, and gave some account of the mode of cultivation.—Mr. A. Smith Woodward exhibited and made remarks on some supposed fossil lampreys (*Paleospondylus gunni*) from the old red sandstone of Caithness.—The Rev. E. S. Marshall exhibited some hybrid willows from Central Scotland, believed to be rare or new to Britain.—Mr. G. N. Douglass exhibited the train of a peahen which had assumed the male plumage. The bird, which was reared at the Castle Farm, Tilquhillie, near Banchory, N.B., was believed to be about thirty years old at the time of its death, and for some years previously had not laid any eggs. In the opinion of the exhibitor and others present the phenomenon was correlated with disease of the ovaries. Similar cases had occurred with fowls, pheasants, and black game, but not, so far as was known, with peafowl.—Mr. C. T. Druery exhibited some new examples of apospory in ferns, namely a specimen of *Athyrium filix fœmina var clarissima* with pinnæ showing development of prothalli by soral apospory, and a seedling *Lastrea pseudomas cristata*, showing prothalli developed aposporously over general surface of frond (pan-apospory).—Mr. J. E. Harting exhibited some live specimens of the short-tailed fieldvole (*Arvicola agrestis*), and gave an account, from personal inspection of the serious damage done by this little rodent upon the sheep-pastures in the lowlands of Scotland.—Mr. A. B. Rendle exhibited some seedling plants of the sugar-cane which had been raised in this country by Mr. Veitch.—The discussion on several of these exhibitions having continued until a late hour, a paper by Prof. Henslow, on a theoretical origin of endogens through an aquatic habit, was by consent adjourned to the next meeting of the Society, which will be held to-day.

Mathematical Society, November 10.—Prof. Greenhill, F.R.S., President, in the chair.—This was the annual general meeting and after the election of the gentlemen whose names are given on p. 616 (NATURE, vol. xlvi.) to serve on the council for the session 1892–93, the new President, Mr. A. B. Kempe, F.R.S., took the chair and at once called upon the retiring president to read his valedictory address. Prof. Greenhill took as his subject collaboration in mathematics.—The following further communications were made. Some properties of homogeneous isobaric functions, by E. B. Elliott, F.R.S. This paper is a sequel to one which the writer communicated at the June meeting entitled a proof of the exactness of Cayley's number of seminvariants of a given type. The earlier part of the present paper supplies omissions in the preceding one and in the remainder the theorem on which Mr. Elliott's argument was based is transformed, and the result examined for its own sake without reference to the particular application.—On certain general limitations affecting hyper-magic squares, by S. Roberts, F.R.S. The paper does not aim at making any addition to the known ways of constructing magic squares. Hyper-magic squares, as the writer regards them, include those called by M. E. Lucas "carrées diaboliques," and also treated by Mr. A. H. Frost under the designation of "Nasik squares." The special form is of ancient origin. The second method given by Moschopulus (thirteenth century) is a general one for forming such squares and they have been discussed by various modern authors. The writer's object is to show some limitations to which they are subject when the elements are positive or negative integers. Incidentally it appears that hyper-magic squares of oddly even orders cannot be formed of series of consecutive natural numbers. There is some reason for believing that much ingenuity has been fruitlessly employed in trying to form such squares. We may here mention that a very interesting historical essay on the subject of magic squares has been published by Dr. Siegemund Günther, in his work entitled "Vermischte Untersuchungen sur Geschichte der Mathematischen Wissenschaften" (Leipsic 1876). The subject has also been brought into connection with the "Geometry of Tissues," by M. Lucas and others (see the "Principii Fundamentali della Geometria dei Tessuti," par Edoardo Lucas, Torino, 1880).—Note on the equation $y^2 = x(x^4 - 1)$ by Prof. W. Burnside.—Note on secondary Tucker circles by Mr. J. Griffiths. The idea of this note sprang from the fact that if G, g, are two inverse points with respect to the circumcircle (ABC) whose centre is O *i.e.* such that $OG \times Og = R^2$, then the pedal triangles DEF, *def* of G, g, with regard to ABC are similar. Taking G to be one of the Brocard points, then (DEF) is a Tucker circle and (*def*) a secondary circle.—On a group of triangles inscribed in a given triangle ABC whose sides are parallel to connectors of any point P with A, B, C, by Mr. Tucker. If DEF, D′E′F′, are a pair of such triangles they are readily seen to be in perspective. Their properties are considered with reference to the principal points and lines of the modern geometry of the triangle.—A note on triangular numbers by Mr. R. W. D. Christie.

PARIS.

Academy of Sciences, November 7.—M. de Lacaze-Duthiers in the chair.—Letter addressed to the President by the committee formed to celebrate the seventieth birthday of M. Pasteur.—Influence of the distribution of manures in the soil upon their utilization, by M. H. Schlœsing.—Note on the reply of M. Berthelot to my note of October 24, by M. Th. Schlœsing.—Comparison of the magnetic observations of General Pevzoff in Central Asia with the data of the English magnetic charts, by M. Alexis de Tillo. General Michael Pevzoff, in his last exploring tour in Eastern Turkestan, made some careful determinations of magnetic declinations and inclinations. If these are compared with those published by M. Creack in the report of the *Challenger* expedition, it appears that in declination an average correction of + 1°·7 has to be applied to the latter, while the inclinations are practically identical.—On the new triangulation of France, by M. L. Bassot. This work was commenced in 1870. It comprised the establishment of a continuous chain between the Spanish frontier and Dunkerque, supporting the net on three base lines, and attaching it as far as possible to each of the parallel chains of the old triangulation. Also a new determination of the co-ordinates of the Panthéon, the fundamental point of the triangulation, the measurements of base-lines in terms of the international metrical standard, and the calculation of the new arc of meridian. It was found that, starting from the Paris base-line, the network was verified at Perpignan, at a distance of 6°, to within 1 in 250,000. Where the French system meets the English, Belgian, and Italian systems, the correspondence is found practically perfect, but on the Spanish frontier there exists a difference of 1 in 65,000 at present unexplained. The arc between Dunkerque and Carcassonne, as now calculated, exceeds that of Delambre by 44·7m., or 1 in 20,000.—Essay on a general method of chemical synthesis, by M. Raoul Pictet.—On the fifth satellite of Jupiter, by M. E. Roger. From the empirical formula for the distances of Jupiter's satellites

$$\log \text{hyp}\, a = 8 - \frac{3m}{2\pi} - 0{\cdot}03 \cos \frac{m\pi}{5} + \epsilon$$

the probable distances of any satellites yet undiscovered can be calculated. It appears that there may be one at distance 1·97, two others at 1·61 and 1·27, or a single one at 1·425, and others beyond the outermost satellite. The distances of those already known are 2·50, 6·05, 9·62, 15·35, and 27·00.—On the transformations of dynamical equations, by M. Paul Painlevé.—Lenticular liquid microglobules and their conditions of equilibrium, by M. C. Maltézos. The smallest drops of a liquid jet falling upon another liquid often assume a lenticular shape, one surface of which is more curved than the other. These are called microglobules. Their diameters were measured, and their volumes and masses calculated. The production of microglobules in all the liquids in Quincke's table was experimented upon.—Effects of weight on fluids at the critical point, by M. Gouy.—Dilatation of iron in a magnetic field, by M. Berget. An elegant experiment to exhibit the lengthening of an iron bar on magnetization, on the principle of Newton's rings. The bar in question, provided with a cap of black glass, presses against the flat side of a plano-convex lens screwed to the same stand. The bar is surrounded by a coil, which can be excited by a battery of accumulators. Magnetization is at once indicated by the expansion of the rings. On the dissipation of the electric energy of the Hertz resonator, by M. V. Bjerknes (see *Wiedemann's Annalen*, No. 9).—On the equality of potential at the contact of two electrolytic deposits of the same metal, by M. G. Gouré de Villemontée.—On the rotating power of the diamine salts, by M. Albert Colson.—Volumetric determination of the alkaloids, by M. E. Léger.—On the fixation of free nitrogen by

plants, by MM. Th. Schlœsing, jun., and Em. Laurent.—Observations on the preceding note, by M. Duclaux.—Observations on the preceding communications, by M. Berthelot.—On γ-achroglobine, a new respiratory globuline, by M. A. B. Griffiths.—On the axinite of the Pyrenees, its forms and its conditions of occurrence, by M. A. Lacroix.—On the subterranean river of the Tindoul de la Vayssière and the springs of Salles-la-Source (Aveyron), by MM. E. A. Martel and G. Gaupillat.—On the comparative anatomy of the stomach in Ruminants, by M. J. A. Cordier.—Remarks on some means of defence in the æolidians, by M. E. Hecht.—On the evolution of the brachial apparatus of some brachiopods, by MM. P. Fischer and D. P. Œhlert.—On the mechanism of solution of starch in plants, by M. A. Prunet.—On the diuretic and ureopoietic action of the alkaloids of cod-liver oil on man, by M. J. Bouillot.—Results obtained at the crystal works of Baccarat by the introduction of metastannic acid into putty powder, by M. L. Guéroult.

BERLIN.

Physiological Society, October 14.—Prof. Munk, president, in the chair.—Prof. Kossel gave an account of further researches on nucleinic acid, a compound which, in union with albumin, composes the proteids of the cell-substance. In earlier researches he had studied the acid as derived from yeast-cells and salmon-milt, and found that while the substances obtained from these two sources differed in many respects, they resembled each other in that the ratio of phosphorus to nitrogen was in both as 1 to 3, and that they both yielded nuclein-bases during their decomposition. More recent researches on the nuclein derived from the leucocytes of the thymus gland have shown that the nucleinic acid it yields is more like that from milt, and resembles the product obtained from yeast even less than does the product from milt. The relationships of nucleinic acid to the chromatin bodies of the histologists were minutely considered.—Prof. Gad brought forward a theory of the excitatory process in muscles, based upon the theory of Fick, but further developed and supported by experiments on tetanized muscles.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, NOVEMBER 17.

ROYAL SOCIETY, at 4.30.—On the Characters and Behaviour of the Wandering (Migrating) Cells of the Frog, especially in Relation to Micro-organisms: Dr. Kanthack and W. B. Hardy.—On the Colour of the Leaves of Plants and their Autumnal Changes: Dr. Hassall.—Stability and Instability of Viscous Liquids: A. B. Basset, F.R.S.—Observations on the Earthquake Shocks which occurred in the British Isles and France during the Month of August, 1892: Prof. Hull, F.R.S.

LINNEAN SOCIETY, at 8.—A Theoretical Origin of Endogens through an Aquatic Habit: Rev. Prof. Henslow.—On the Buprestidæ of Japan and their Coloration: G. Lewis.

CHEMICAL SOCIETY, at 8.—Fluo-sulphonic Acid: T. E. Thorpe, F.R.S., and William Kirman.—The Interaction of Iodine and Potassium Chlorate: T. E. Thorpe, F.R.S., and George H. Perry.—The Magnetic Rotation of Sulphuric and Nitric Acids and their Solutions: also of Solutions of Sodium Sulphate and Lithium Nitrate: W. H. Perkin, F.R.S.—Note on the Refractive Indices and Magnetic Rotation of Sulphuric Acid Solutions: S. U. Pickering, F.R.S.—Hydrates of Alkylamines: S. U. Pickering, F.R.S.—On the Atomic Weight of Boron: W. Ramsay, F.R.S., and Miss Emily Aston.—And other papers.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Problems of Commercial Electrolysis: James Swinburne (Discussion.)

LONDON INSTITUTION, at 6.—Lincoln Cathedral (Illustrated): Rev. Canon Edmund Venables.

SUNDAY, NOVEMBER 20.

SUNDAY LECTURE SOCIETY, at 4.—How Weather Forecasts are arrived at, and how we should use them (with Oxy-hydrogen Lantern Illustrations); Arthur W. Clayden.

MONDAY, NOVEMBER 21.

SOCIETY OF ARTS, at 8.—The Generation of Light from Coal Gas: Prof. Vivian B. Lewes.

ARISTOTELIAN SOCIETY, at 8.—The Nature of Physical Force and Matter: R. J. Ryle.

LONDON INSTITUTION, at 5.—Respiration in Man and Animals (Illustrated): Hy. Power.

TUESDAY, NOVEMBER 22.

INSTITUTION OF CIVIL ENGINEERS, at 8.- Halifax Graving-Dock, Nova Scotia: Hon. R. C. Parsons.—Cockatoo Island Graving-Dock, New South Wales: E. W. Young.—The Alexandra Graving-Dock, Belfast: W Redfern Kelly.—Construction of a Concrete Graving-Dock at Newport, Monmouthshire: Robert Pickwell. (Discussion.)

WEDNESDAY, NOVEMBER 23.

GEOLOGICAL SOCIETY, at 8.—Outline of the Geological Features of Arabia Petræa and Palestine: Prof. Edward Hull, F.R.S.—The Marls and Clays of the Maltese Islands: J. H. Cooke.—The Base of the Keuper Formation in Devon: Rev. A. Irving.

SOCIETY OF ARTS, at 8.—Cremation as an Incentive to Crime: F. Seymour Haden.

THURSDAY, NOVEMBER 24

INSTITUTION OF CIVIL ENGINEERS, at 2.30.—Students' Visits to the Gas Light and Coke Company's Chief Office, Horseferry Road, Westminster.

LONDON INSTITUTION, at 6.—The Ruined Cities of Mashonaland (Illustrated): J. Theodore Bent.

FRIDAY, NOVEMBER 25.

PHYSICAL SOCIETY, at 5. Experiments in Electric and Magnetic Fields, Constant and Varying: E. C. Rimington and E. Wythe Smith.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The Value of Hypnotism in Chronic Alcoholism: Dr. C. L. Tuckey (Churchill).—Guide to the Science of Photo Micrography, 2nd edition: E. C. Bousfield (Churchill).—Das Centralnervensystem von Protopterus Annectens: Dr. R. Burckhart (Berlin, Friedländer).—Aids to Experimental Science: A. Gray (Auckland, Upton).—The Outlines of Organic Chemistry: C. J. Leaper (Iliffe).—Théorie Mathématique de la Lumière: H. Poincaré (Paris, G. Carré).—A Sequel to the First Six Books of the Elements of Euclid, 6th edition: Dr. J. Casey, edited by P. A. E. Dowling (Longmans).—The Jurassic Rocks of the Neighbourhood of Cambridge: T. Roberts (C. J. Clay).—Fossil Plants as Tests of Climate: A. C. Seward (C. J. Clay).—The Collected Papers of Sir Wm. Bowman, Bart., F.R.S.: vol. 1, Researches in Physiological Anatomy, edited by Prof. J. Burdon-Sanderson; vol. 2, Surgical and Ophthalmological Papers, edited by J. W. Hulke (Harrison)—The Fayûm and Lake Mœris: Major R H. Brown (Stanford).—Text-book of the Embryology of Man and Mammals: Dr. O. Hertwig, translated by Dr. E. L. Mark (Sonnenschein).

PAMPHLETS.—A Sanitary Crusade through the East and Australia (Glasgow, Boyle).—Geologische und Geographische Experimente; ii. Heft, Vulkanische und Massen-Eruptionen: E. Reyer (Leipzig, Engelmann)—The Gods of Greece, and other Translations: Dr. J. F. Whitty (Grocock).—First Series of Field-path Rambles round Bromley, &c.: W. Miles (Taylor).—Un Avance á la Antropologia de España: L. de Hoyos Sáinz and T. de Aranzadi (Madrid).—Appunti in Conferma delle Osservazioni Tromometriche: P. T. Bertelli (Torino, Giuseppe).

SERIALS.—Journal of the Royal Horticultural Society, vol. xiv.; Report of the Conifer Conference (London).—Himmel und Erde, November (Berlin, Paetel).—Bulletin de la Société Impériale des Naturalistes de Moscou, 1892, No. 2 (Moscou).—Quarterly Journal of Microscopical Science, November (Churchill).—The Kansas University Quarterly, October (Lawrence, Kansas).

CONTENTS.

PAGE

THURSDAY, NOVEMBER 24, 1892.

ANIMALS' RIGHTS.

Animals' Rights. By H. S. Salt. (London: Bell, 1892.)

THIS little volume is divided into three main parts, the principle upon which the rights of animals are founded, the various ways in which they have been infringed, and the reforms necessary to secure their full recognition. Notwithstanding, however, the logical form in which the subject is thus set forth, the book is absolutely useless both from the ethical and the practical points of view. In the first place the author nowhere attempts to define the relative value of the lower animals as compared with the human race, and although he certainly allows that they possess less "distinctive individuality," he condemns the use of the terms by which they are commonly designated (such as dumb beast, live stock, or even animal), on account of the imputation of inferiority which is involved in them.

He seems to be totally unaware that not only is the natural affection of animals far less enduring, and their intellect immeasurably weaker, but that of morality, *i.e.* the doing of right for right's sake alone, unswayed by personal feeling or the influence of others, they have absolutely no conception whatever.

Ignoring, however, these fundamental distinctions from which the subjection of animals inevitably follows, Mr. Salt at once proceeds to enunciate his theory of their rights.

This whole question, however, is thrown into absolute chaos by the fact that, for subsequent dealing with the practical aspects of his subject, the author has equipped himself with not merely one but two definitions of animals' rights, differing from each other so widely that while the one involves the unconditional prohibition to kill, eat, or use any harmless animal, the other would admit of all these things being done for good cause shown. Thus on page 9 we find that they have the right to live their own lives with a due measure of that restricted freedom of which Herbert Spencer speaks, *i.e.* the freedom to do that which they will, provided they infringe not the equal liberty of any other. Except, therefore, in the case of the beasts of prey, who no doubt would "will" to eat man if a convenient opportunity offered, the liberty to sacrifice the lives of animals for human food or indeed to employ them in any way is cut off without reserve. Turn, however, to page 28 and we find that this freedom of animals is no longer restricted merely by the equal freedom of others, but is also "subject to the limitations imposed by the permanent needs and interests of the whole community." A life of idleness and a death from disease or old age and starvation are no longer secured to them, and the whole principle of the subordination of the interests of the lower race to those of the higher is conceded.

From the confusion of mind thus exhibited suggestions of practical value can scarcely be expected, nor indeed do we find them in the succeeding parts of the work. Thus we are told that "the contention that man is not morally justified in imposing any sort of subjection on the lower animals" is one which the author "desires to keep clear of," and pronounces to be "an abstract question beyond the scope of the present enquiry," yet, as he also states "that no human being is justified in considering any animal as a meaningless automaton to be worked, tortured, or eaten for the mere object of satisfying the wants or whims of mankind," we would submit that he has not kept clear of the matter at all, as we cannot call to mind any forms of subjection which are not included in these three.

In his discussion of the treatment of domestic animals we would only draw attention to that passage wherein the degrading practice of pampering lap-dogs is rebuked as unworthy of their moral dignity! In the succeeding chapters the employment of animals in personal decoration, sport, and scientific experiment is dilated upon and condemned, and it then only remains to consider the question of the reforms which ought to be instituted.

The first remedy proposed is that of education. We are all to be taught to be humane, but seeing that this has been, for countless generations, carried into effect by almost every mother with almost every child, the suggestion can hardly be accounted novel nor need any great changes in the present condition of affairs be expected from it. Further, there must be a crusade preached against the disregard of the kinship of animals to ourselves, and the laugh must be turned from the so-called sentimentalists (*i.e.* those agreeing with the author's views) against certain flesh eaters, sportsmen, and scientific experimentalists whom he seems to have in his mind's eye, and who, seeing that he represents them as advancing absolutely foolish reasons for practices which they could easily defend on common-sense grounds, are very properly described by him as "cranks."

The second reform is to be found in legislation, and it might naturally be supposed that this should first be applied in that case which Mr. Salt considers to be productive of the greatest bulk of suffering, namely in that of flesh eating. But this is not so; he has already said that it is no part of his present purpose to advocate vegetarianism, and he discreetly leaves it to look after itself. Then after suggesting that the worrying of tame animals might be classed as baiting, and that improvements (though what and how he does not say) might be made in the transport of animals, and by substituting public for private slaughter-houses, he demands that the full fury of the law should be turned on to scientific experiment, which must be totally abolished.

The demand thus made he bases on two grounds:—(1) That nothing is necessary which is abhorrent to the general conscience of humanity, and (2) That it involves hideous injustice to innocent animals, quoting with approval Miss Cobbe's, in this case, specious axiom, that the minimum of all possible rights is to be spared the worst of all possible wrongs.

How far either of these arguments is applicable here we propose to briefly touch upon.

In the first place no proof whatever exists that scientific experiment *is* abhorrent to the general conscience, seeing that England is the only country where it is even under legislative supervision, that there, after the most careful deliberation, it is freely allowed on good cause shown, and that the whole body of those qualified to

judge strongly advocate it. Supported, therefore, as we have shown it to be, by the legal and moral sanction of the civilized and scientific world, it follows that the "general conscience" of which Mr. Salt speaks must find its local habitation in the minds of a class of persons about as enlightened as those who fomented the riots against the study of anatomy, a noisy and violent agitation, which has died the natural death of ignorant prejudice.

For the refutation of the second proposition, viz. that of the cruel *wrong* done to an innocent animal by sacrificing it for the good of others, we must refer Mr. Salt to his own principle of animals' rights, in which the freedom conceded to them to live their own lives is very properly made "subject to the limitations imposed by the permanent needs and interests of the community," and we fail to see how the logical application of an acknowledged right can be supposed to involve the infliction of a "cruel wrong."

The contention of the scientific experimentalist is exactly that which is here conceded by Mr. Salt, viz. that the interests of individuals of the lower race must morally be treated as subordinate to those of the higher, and that while men are bound to benevolently regard all harmless animals, and never to inflict pain upon them wantonly, they not only may but ought to do so when the suffering thus caused is but one-tenth in intensity and one-millionth in quantity of that which it is designed to avert from both mankind and the lower animals. The whole matter is in truth a rule of three sum, and unless the anti-vivisectionist can successfully demonstrate that the scientific statement of accounts is false, his outcry is but the confession of the immoral fact that, rather than inflict an infinitely less amount of physical suffering upon some individuals of a lower race, he wilfully prefers to perpetuate a far greater amount of both physical and psychical agony among the whole community of animals and men. When such an avowal of callousness can be seriously advanced in the name of humanity we are tempted to believe that chaos is come again.

We should not omit to mention that Mr. Salt appears to be an ardent republican, and that he looks for the advent of his animal millenniun upon the establishment of an "enlightened sense of equality," but whether of men with animals, of both with insects, or all three with bacteria, he does not say, nor are we concerned to enquire.

ELEMENTARY PHYSIOGRAPHY.

A Description of the Laws and Wonders of Nature. By Richard A. Gregory, F.R.A.S. (London: Jos. Hughes and Co.)

NOTWITHSTANDING the numerous text-books that have been issued from time to time on this subject, it seems to Mr. Gregory that there is still room for another, for whose appearance, however, he apologizes and offers an explanation.

A work on physiography is not, as some people, who ought to know better, seem to think, limited to the study of physical geography. At least that is not the view, the author emphatically asserts, of Profs. Judd and Lockyer, whose opinion in this matter is final for the students interested. Neither is it a work on astronomy, nor chemistry, nor geology, nor any specialized science, whose aim and scope are recognized and defined, though doubtless it is allied to all. As soon as an author treats of any of these subjects in detail, he is travelling beyond the record. To this fact Mr. Gregory is fully alive. His object, if we have understood him correctly, consists rather in showing that some knowledge of all branches of physical science is necessary for the pursuit of one, and this kind of general knowledge he considers comprised under the generic term, physiography. It is the kind of information which every so-called educated person ought to possess, and without which he is not educated.

It may not seem a very ambitious task to write a book to meet the requirements of a syllabus, and our author thinks it necessary to defend himself against the charge of producing a cram book, addressed to the few ambitious of possessing a South Kensington certificate. But the task need not be the less useful or the less necessary on that account. Indeed, there is one circumstance connected with the appearance of this book which is very satisfactory, and should be a subject for congratulation. The author asserts that the book is rendered essential from the fact that the examiners have found it necessary or desirable to raise their standard for examination. This means that the Department has proved, that the general character of the education given to tnose classes from which the candidates for examination are drawn has so improved that a greater amount of information can be demanded than was formerly the case.

But independently of the fact that the author addresses himself principally to those preparing for the ordeal of examination, he has produced a very readable book, a little too much like an encyclopædia perhaps for ordinary tastes, but replete with a vast deal of information, by no means ill-arranged and generally expressed with exactness; but the effort to impart and to treat lightly and discursively of many branches of information is apt to give to the book a disconnected and incoherent aspect, and this is the principal defect that can be urged against the work. As soon as a subject is introduced it is necessary to drop it, because to pursue it in detail would be to enter into the domain of some science whose limits are fixed, and to which further discussion properly belongs—for instance, we have a chapter on water (its composition and different states), which it might seem very desirable to pursue at greater length; but as soon as the student gets interested, without a word of warning the subject is dropped, and he finds himself introduced to the method of measuring angular space and time. This naturally leads on to some preliminary account of astronomy and astronomical methods, ending with the measurement of the day and year, and then, on turning the page, the reader is not allowed to continue the subject, but is invited to consider the composition and characteristics of common rocks. This incoherency is perhaps inseparable from the subject; but we think the author might have developed his introductory chapter at greater length and put his scheme and sequence of thought more fully before his reader, so as to prepare him for these sudden deviations from continuity.

It is instructive to notice that as educational treatises are improved in character and prepared by those qualified for the task, the reverent superstition which has for ages surrounded certain errors and fallacies, that have done duty for scientific reasoning, is being remorselessly swept away. The so-called proof of the sphericity of the earth, based upon the fact that ships have sailed round it, is not quoted now, even by incompetent teachers, with the same satisfactory conviction that was formerly accorded to it. Mr. Gregory gives a diagram which ought to convince the most antiquated schoolmistress, but such myths die hard. Similarly with our friend "the burning mountain," which has frequently been regarded as an adequate definition of a volcano—that too is meeting with its deserts; but this will take a still longer time to kill, let Prof. Judd and others insist as they will. Many instances will occur to every one who has compared the carefully compiled text-books of to-day with those that were popular only a few years back, and no fact marks more emphatically the improvement, or the necessity for improvement, in educational treatises. Definitions, to be accurate and adequate, will always be a source of trouble to the writers of elementary books, and the author of the present work has no doubt been exercised to combine the necessary accuracy and simplicity. We cannot think that he has always been happy, but where so much is admirable it would be ungrateful to dwell upon small blemishes, and can only be permitted with the view of securing their improvement or removal in a future edition.

The definition of meridian as given on page 105 and again at page 151 is susceptible of improvement, and it is certainly incorrect to describe a sidereal day as the interval of time that elapses between two successive transits of the same star. Such little slips must be due to the hurry of production, as that on page 382, where we are told to determine the position of the north point by observing the "shadow of the sun." We should have thought the shadow of the object would have been more convenient. And again, on page 407, what is meant by the sun's "regular diameter"? But such little slips as these do not materially detract from the merit of the book, which we heartily commend to the thoughtful study of those for whom it has been written.

SCIENCE AND BREWING.

A Handy Book for Brewers. By Herbert Edwards Wright, M A. (London: Crosby Lockwood and Son, 1892.)

THE author claims that the principal aim of this book is to give the conclusions of modern research in so far as they bear upon the practice of brewing. We gathered a different opinion on first opening the volume, for facing the title-page there stands conspicuously a trade advertisement of a firm manufacturing a patented article used by brewers, stating that this article is "referred to in the work," and "for further particulars see advertisement at end of book." To any one at all familiar with the way in which quasi-scientific articles are so frequently to be met with in the literature of brewing written for the purpose of advertizing their author or some other thing, it would be only natural to conclude that the advertisement quoted was the real clue to the origin of this volume, and wonder at the unusual clumsiness with which it was made so evident. However, we afterwards meet with the following statement in the author's preface: "Having found after the sheets had been finally passed to the printer, that the publishers considered it would be a useful feature in the book to insert a few advertisements of matters interesting to brewers, he wishes it to be clearly understood that he has no personal interest in the matter." A little prejudice perhaps remained in our mind even after reading this disclaimer, but in justice to the author we may say at once that a perusal of the book has removed it. We sympathize with him in having a publisher whose disinterested over-zeal for the convenience of his readers has given his book such an unpleasant first impression.

From a scientific point of view, in one respect the practice of brewing compares with the practice of medicine, in that the complexity of vital processes has to be encountered in both, and through our present imperfect state of knowledge of these questions, the practice of both is based very largely on empiricism. Fortunately for the brewer, the life functions with which he has to deal so largely belong to the more simple forms of life, and the vast strides which have been made the last few years in our knowledge of the microphytes, and the physiological processes of the higher plants, have probably placed him much nearer to a sound scientific basis on which to rest his practice, than is the physician who has to deal with the vital functions of the most highly developed organism. But even yet empiricism rules many details of the brewer's practice, although research is gradually throwing true light upon them; therefore any writer who, in the present state of things, attempts to bring scientific knowledge and the practice of brewing together, has a very hard task before him in order to clearly make his readers understand the relative position in which the two stand at present. Mr. Wright has with much diligence gathered together the results of a large amount of research work bearing upon the different stages of the brewing process, but we do not think that he has been always happy in selecting only the most trustworthy of these, neither are we pleased with the way in which he sets them before his readers to explain, or at any rate throw light upon, the different stages of the manufacturing process. It is a very difficult task, as we have just intimated, and we believe that the author, who is evidently a scientific man as well as a practical brewer, could have improved upon these parts of his work; at any rate we are quite sure that with due consideration he could easily have improved upon the general arrangement of his subjects, which is badly considered, and must be very confusing to a student not well acquainted with his subject.

We also regret that space is wasted in devoting a chapter to an attempt to teach the science of chemistry to the reader. Some such mistaken attempt is frequently made in technical works treated scientifically, but a greater waste of paper can hardly be imagined. For instance, in the present case we have a chapter starting with a description of the elements and the atomic theory, which positively, in less than thirty-five pages, professes to lead the reader up to the consideration of the con-

stitution of the carbo-hydrates and the amido-compounds. What can be the use of this sort of writing, however well done? No student not already well grounded in science generally can hope to get any real advantage from those parts of this book that are devoted to the scientific consideration of the details of the brewing process, and we wish the author had boldly recognized this very evident fact.

Apart, in a manner, from the more scientific portions of his book, the author gives us his views on the empirical questions of brewing, and also on the arrangement of a brewery and its plant, with the authority of much experience. Here is common ground on which all interested in brewing meet, and we recommend the author's conclusions as worth their attention. At the end of the volume we find a novel feature in a synoptic table of the malting and brewing processes, giving side by side the time, working memoranda, physical changes, and chemical changes of each process, an epitome which is likely to be useful to many readers. A good index also adds value to the book.

Although we do not think that the author in writing this book has been very successful in meeting the requirements of young students of brewing, yet there is a large amount of information contained in the 516 pages of the volume which will repay a careful perusal by those more advanced in the study of the scientific aspect and practice of brewing.

OUR BOOK SHELF.

A Manual of Veterinary Physiology. By Vety.-Captain F. Smith, M.R.C.V.S. (London: Baillière, Tindall, and Cox, 1892.)

THE publication of this work ought to delight the heart of the veterinary student, for hitherto in his pursuit of physiological knowledge he has been compelled to rely upon works which deal exclusively with the human subject. However excellent such works may be and well adapted to the requirements of the human physiologist, they must necessarily contain much which is only of secondary importance to the veterinary student, and absolutely nothing concerning many questions which to him are of vital interest. For example, how needful to him is a thorough knowledge of the physiology of the horse's foot—the seat, as he is afterwards to learn, of manifold diseases. Yet clearly the consideration of this subject is outside the range of human physiology. Similarly the composition, digestibility, and feeding properties of the foods supplied to the various domestic animals are to him matters of paramount importance. Yet here again he finds himself left in the lurch by the standard works on human physiology. Such considerations amply indicate the necessity for a work of the kind now before us, and cause us to wonder that the veterinary profession should have had to wait so long for its publication. Though several first-rate treatises on veterinary physiology exist in French and German literature, Captain Smith's is the first attempt, we believe, to deal with the subject in its entirety in this country.

We can heartily congratulate the author on the manner in which he has performed his task. He writes in a concise but precise style. Bearing in mind how many subjects the student is supposed to take up and master in a comparatively short time, the author has omitted, and we think wisely so, the details of physiological experimental methods and descriptions of elaborate mechanical appliances employed in the laboratory.

The value or usefulness of the horse depends so largely upon its powers of speed or draught that a knowledge of its locomotory apparatus is obviously imperative to the veterinarians. During recent years much light has been thrown upon the subject of animal locomotion by the elaborately devised experiments of Stillman and Muybridge, carried out, as is well known, by means of instantaneous photography. Captain Smith furnishes a capital *résumé* of the conclusions derived from these experiments and a number of plain, simple diagrams aid the reader considerably in comprehending the subject.

The physiology of the horse's foot is dealt with in a somewhat short chapter. The author adheres to the theory of the expansion of the foot at its posterior part when the weight of the body is imposed thereon. It is a subject which has often been hotly debated, and its discussion will probably be again reopened in the columns of the veterinary periodicals. The chapter concludes with some half-dozen rules on physiological shoeing, a copy of which might well be suspended and acted upon in every place where the shoeing of the horse is carried on.

The book is well printed, neatly bound, and published at a very reasonable price (10*s.* 6*d.*). Horse-owners as well as veterinarians will find its perusal attended with profit as well as interest. W. F. G.

The Principal Starches used as Food. By W. Griffiths. (Cirencester: Baily and Son, 1892.)

THIS little book of 62 pages will be found useful by analysts and others who are interested in the examination of foods. The author has collected together short descriptions dealing with the origin and microscopical characters of the different starches met with in commerce—the arrowroots, tapioca, sago, the starches of our common cereals, and of millet, maize, rice, the bean, the pea, the lentil, the potato, and so forth. These are classified according to the natural orders of the plants from which they are derived, and the descriptions are accompanied by remarkably good photo-micrographs, which indicate at a glance the peculiarities of the different varieties. The mode of classification serves to bring out the resemblances which often exist in starches obtained from plants of the same natural order. Since the microscope alone can be employed in attempting to trace the origin of a starch, and bearing in mind the extent to which it is now used as an adulterant, this handy little book will no doubt supply a want.

Three clerical errors were noted. On p. 47 "feint" should be "faint," and "not" is evidently omitted in line three from the bottom. On p. 48 "character" should be "characters."

Les Alpes Françaises. Par Albert Falsan (Bibliothèque Scientifique Contemporaine. (Paris: J. B. Baillière et Fils, 1893.)

WE cannot call this a successful book. A mixture of condensed statistical information and of popular descriptive writing is not much better than a stirabout of Liebig's extract and of trifle-whip. Fixity of purpose on the author's part is also wanting. Doubtless the French Alps cannot be separated from the rest of the chain, but for a book of only 286 pages all told, this contains too much about the Central, Pennine, and Eastern Alps. The geological part is sketchy, and not always very accurate. The author repeats the old mistake about the "variolite of the Durance forming a fringe to the euphotide," though the question was settled by the elaborate paper of Messrs. Cole and Gregory, published in the *Quarterly Journal* of the Geological Society for 1890. The illustrations are numerous; few, however, of them are good, and several very bad. There is no index. The work, in short, is a piece of book-making, characteristically French in style, and is not a valuable addition to the library either of the mountain-climber or of the man of science.

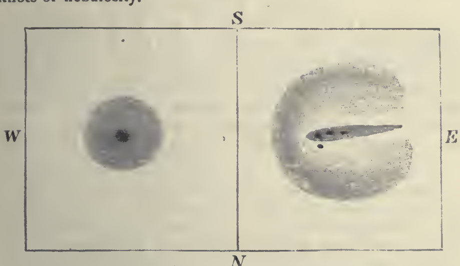
LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The New Comet.

THE comet discovered by Mr. Holmes on November 6 was observed here on November 9 at 5h. 50m., and found to consist of a very bright circular nebulosity with central condensation. The diameter of the comet was 5′ 41″.

It was re-observed on November 16 at 10h. 45m., and its physical appearance seemed to have undergone a complete transformation. The diameter had increased to 10′ 33″, and the cometary material had become much fainter and more irregular. The nucleus was now in the form of a bright streak, and this was enveloped in a large faint coma. A small star was seen just N. of the W. extremity of the nucleus, and the latter seemed composed of knots of nebulosity.



Nov. 9, 5h. 50m. Nov. 16, 10h. 45m.

On November 19, 14h. 15m., the comet was seen again. Its general aspect was much fainter, and it exhibited a further increase in dimensions. I carefully determined its diameter as 14′ 30″, but the outlying portions were very tenuous and indefinite.

From Berberich's elements given in Edinburgh circular No. 33, it appears that the comet is moving rapidly away from the earth. The great increase in its apparent diameter is therefore not a little remarkable. On November 9 the comet was about 203 millions of miles distant from the earth, and its real diameter must have been 333,000 miles. On the 16th this had increased to 652,000 miles. By the 19th the comet's distance had become 217 millions of miles, and its real diameter 925,000. In ten days, therefore, the cometary material expanded nearly threefold.

Bristol, November 20. W. F. DENNING.

The Light of Planets.

A FEW facts relative to this subject may be interesting. At Plymouth on August 12, about 9 o'clock, favoured with a beautifully clear horizon, the brilliancy of Mars was so great that it cast a distinctly black shadow on a piece of white paper from an ordinary walking stick held at a distance of 4½ inches; the outline of the hand, under the same conditions, was also easily perceptible. A faint, yet decided, darkening of the white cliffs of the shore was caused by a person standing upright—the slope being about 45°. The point of observation was at the extreme north-west of the Sound, and the splendour of the planet's light reflected from three or four miles of water is perhaps unrivalled.

The light of Jupiter has often enabled me, when using the telescope at a southern window, to make drawings and such references to books, &c., as were found necessary, without any other illumination. JOHN GARSTANG.

Springwell House, Blackburn, November 21.

Rutherfurd Measures of Stars about β Cygni.

IN order to prevent any possible misapprehension in connection with your notice (NATURE, vol. xlvi. p. 619) of Mr. Rutherfurd's measures of the stars surrounding β Cygni, may I call attention to the following ?—The two stars of Argelander, 27.3435 and 28.334, concerning which a doubt is expressed in my paper, are certainly lacking on the Rutherfurd plates. If they were present they would be very near the edges of the plates, and it is for this reason that I doubted whether we should expect to find them at all. The star numbered 28 in the Rutherfurd list, which appeared only as a sort of elongation of No. 27 on a plate taken at this Observatory, April 19, 1892, is one of the components of Σ2539, as was pointed out by Mr. Burnham in the *Astronomical Journal*, No. 268, and by myself in the same journal, No. 266. HAROLD JACOBY.

Columbia College Observatory, New York, November 11.

The Alleged "Aggressive Mimicry" of *Volucellæ*.

MR. POULTON'S letter calls for few words in reply. I invited Mr. Poulton to produce observations in support of his statement that the two varieties of *Volucella bombylans* lay in the nests of the bees which they respectively resemble. To this invitation Mr. Poulton has not responded. He tells us that his account represented "a very general impression"; that the same impression has been set forth in a showcase at the Museum of the Royal College of Surgeons; that even if he were mistaken it was well, if through his mistake the truth shall the more abound. It is thus admitted that in making that statement Mr. Poulton relied not on original authorities, but on the general impressions of others. That these impressions are in any sense correct there is as yet no evidence to show.

Compared with this, Mr. Poulton's error as to *Bombus muscorum* is of course comparatively trifling and it would be useless to pursue the matter, were it not for discoveries made in the process of unravelling it.

I pointed out that *V. bombylans* is common in nests of *B. muscorum*, a bee which it does not resemble. Mr. Poulton in reply maintains the opinion that *V. bombylans* var. *mystacea* does resemble *B. muscorum*. In defence of this statement he refers to (1) the showcase at the Royal College of Surgeons, where the resemblance is set forth; (2) a recent book, "Animal Intelligence," by Mr. Lloyd Morgan, where the resemblance is again asserted and illustrated by figures of insects in the similar showcase at the Natural History Museum.

In following up these clues I came to unexpected results. (1) There is at the College of Surgeons a showcase, as stated, illustrating the likeness of *Volucellæ* to humble-bees. The label states that "the resemblance enables them [the flies] to escape detection." Two bees are exhibited bearing a good likeness to the var. *mystacea*, and, as Mr. Poulton says, they are labelled "*B. muscorum*." The one, however, is a worker of *B. sylvarum L.*, and the other is probably a male of the same species. Neither can be mistaken for *B. muscorum*, which they do not resemble.

(2) At the Natural History Museum bees of several species are shown beside the *Volucellæ*, with a similar statement that the resemblance enables the flies "to enter the nest of the bee without molestation." Not one of these bees is *B. muscorum*, nor are any of them said to belong to this species, for no names are given. Nevertheless, on turning to Mr. Lloyd Morgan's book, which I had not before seen, I find the statement (p. 90) that *V. bombylans* "closely resembles" *B. muscorum*, the passage continuing in the words of the Natural History Museum label. Figures are added showing the two forms of *V. bombylans* and two very different bees, *both* marked "*B. muscorum*." Now the figures are from *photographs* of certain specimens in the showcase, and on reference to the specimens in question, it appears that one of them is a yellow-banded humble-bee (perhaps *B. hortorum*), while the other is one of the red-tailed humble-bees! These two are put out to match *V. bombylans* and the var. *mystacea* respectively, and of course have no likeness either to each other, or to *B. muscorum*, though both are referred to this species by Mr. Lloyd Morgan.

Mr. Poulton's choice of *B. muscorum* as a form resembled by the var. *mystacea* probably therefore arose from the wrong naming at the Royal College of Surgeons. How Mr. Lloyd Morgan came to call the two different bees by the name *B. muscorum*, which belongs to neither, I cannot tell. Perhaps this is in part an echo of Mr. Poulton's previous mistake.

Any one by reference to a collection of bees may easily satisfy himself that the common and ordinary *B. muscorum*, with its bright brown thorax, does not resemble *V. bombylans*, though this fly is common in its nests, just as *V. pellucens* lives in wasps' nests, though it does not resemble a wasp.

In the absence of direct evidence in its favour, and inasmuch

as it is inconsistent with many ascertained facts which were specified in my first letter, the hypothesis of "Aggressive Mimicry" should surely be withdrawn.

No speculation is needed to enhance the exceptionally interesting facts of the Variation and the resemblances of the *Volucellæ*. If a number of people will set to work on this problem in the way suggested, there is, I think, a fair chance of considerable results. It was in the hope that such effort may be made that I drew attention to the matter, and I am really sorry that Mr. Poulton should be hurt thereby. Nevertheless, I cannot but regard his account of the matter as an example of the way in which statements pass on from one writer to another, but prove on inquiry to be baseless. WILLIAM BATESON.

St. John's College, Cambridge, November 14.

Parasitism of *Volucella*.

MR. BATESON'S interesting discussion of the relations between *Volucella* and the species of *Bombus* (NATURE, vol. xlvi. p. 585) suggests the following observations:—The nest of *B. muscorum* is made without much effort at concealment on the surface of the ground. If accidentally disturbed the inmates set up a peevish buzzing, which, no doubt, answers the purpose of warning off ordinary intruders. Yet *B. muscorum* is of a patient and gentle disposition, and will put up with a good deal of maltreatment before using its sting. Its sting, moreover, is less venomous than that of either of our other common humble bees. It apparently trusts to the reputation of its genus for protection from annoyance. Such a creature would seem marked out by Nature as the very host to be imposed on by a parasite like *Volucella*, which, on the other hand, may need all its cunning to come round an irascible being like *B. lapidarius*, or even like *B. hortorum*. And, in fact, as Mr. Bateson points out, we find it multiplying abundantly at the expense of the first named bee, and less frequent in the nests of the other two. Notwithstanding this, *B. muscorum* appears to be certainly no less successful than either of the others in the struggle for existence. W. E. HART.

Falmore, Carrowmena, co. Donegal.

Optical Illusions.

THE illusion of the Gothic arch in NATURE (vol. xlvii. p. 31) is too good to have a rival, but simple Norman arches occasionally practise a deception of some subtlety. In certain cases they seem to be of the Moorish horse-shoe form; this happens when the semicircle does not spring at once from the capitals of the Norman columns, but has a short intervening vertical space of masonry. Architects are familiar with the effect, and call these arches stilted; they say the stilts are commonly vertical, although Norman walls have no doubt sometimes fallen away from the upright course. I suppose the eye is quick enough to perceive that there is more than a semicircle, while the mind is gullible enough to infer that the curvature is continued. In Winchester Cathedral there are some good illustrations of this appearance.

Winchester College, November 12. W. B. CROFT.

A Strange Commensalism—Sponge and Annelid.

A CURIOUS case of what I believe to be definite commensalism between members of these two classes came under my notice the other day when collecting, and, as it is, so far as I know, a new instance in this interesting inter-relationship between animals, I venture to record it.

Several large patches of crusting orange-red sponge attracted my attention because of the peculiarly emphatic markings of what appeared to be the oscula. They were suspiciously unlike anything spongiform, so I secured some good pieces of the sponge for further investigation. Sections proved them to belong to the *Microciona plumosa* of Bowerbank, but the supposed oscula—which to the naked eye appeared as innumerable tiny black specks, each surrounded by a grey ring—proved to be, when the mass was teased out in water, in reality the ends of tubes inhabited by an eyeless *Leucodore* (*L. cœca*, Œrsted). Fully forty could frequently be counted in a square inch.

The conclusion I come to after examination of a large number of specimens is that actual benefit is mutually given and received by each of the two messmates; the sponge gaining considerable support and extra consistency from the numerous comparatively wiry upright tubes. There is also the question whether the excreta of the worms is of any food value to the sponge. On the part of the worm, there is little doubt that it finds a valuable protector in the sponge which by the way is characterized by an intensely rank smell of garlic (warning odour?). I have seen no signs of this sponge being preyed upon by any animal, so we may conclude its protective devices of spicules, odour or taste are fairly successful. A worm whose tube is sunk completely in its substance will naturally be very safely housed, and besides, the friendly water-currents set in motion by the sponge cilia will bring much food matter to its very mouth.

Bowerbank in his description ("Br. Spongiadæ," vol. ii. p. 134) writes of a specimen as "permeated by some small tubular zoophyte which it has coated with its own tissues, and from these adopted columns defensive spicula are projected"—evidently the same as I describe above, though he makes the mistake of considering the tubes as those of zoophytes instead of those of annelids. From this quotation, however, it is evident that the habit is widely spread, and not merely local. Here at extreme low-water the sponge grows exceedingly abundant, and the commensal worm seems always present.

JAMES HORNELL.

Jersey Biological Laboratory, November 10.

Induction and Deduction.

MR. DIXON says that there are "at least three different kinds of interpretation which may be put upon the proposition, [An isosceles triangle has equal angles at the base]. It may mean (1) the triangle used to illustrate this proposition has equal sides, therefore it has equal angles; or (2) I have conceived a triangle which has equal sides, therefore I have conceived one which has equal angles; or (3) the connotation ascribed by the adjective isosceles implies the connotation 'having equal sides' [? angles]."

He goes on to observe that the difference between either (1) or (2), and (3) is "that this latter gives us no information about any real thing or concept, but only about what is implied by using certain terms," that is, about the connotations of "isosceles" and "having equal angles" ("equal sides" is of course a slip). But if connotation refers neither to the attributes of "real things" nor to "concepts" (which I suppose means ideas or notions) what can it be that we "imply" by using the terms *isosceles*, &c.? If we do not mean things, nor attributes of things, nor ideas, do we mean anything which can convey or contain information?

In Mr. Dixon's view the terms do convey information, but information which "clearly does not require to be based upon any real knowledge of things, but may be based solely on definitions of words." But must not definitions of words be based, in the last resort, upon knowledge either of things or of concepts—definitions of current words in some current sense, or even of strange words in strange senses—as *e.g.* if I say Abracadabra means ixtra-mixtra, and Triangle means abracadabra, and all abracadabras are four-sided, and so on? With such propositions I may certainly frame syllogisms and arrive at "symbolical" conclusions, though I cannot see that I shall be doing anything to convey information or to advance thought.

And when Mr. Dixon says that the proposition "an isosceles triangle has two equal sides" has "wide applicability and usefulness" because we "often find things which can fairly be called isosceles triangles," it seems clear that he himself cannot have taken the proposition at starting in a sense purely "symbolic" (in his meaning of that word). If he did, it would be little less than miraculous that an entirely arbitrary definition should happen so to fit actual experience, especially when we consider that other equally symbolical mathematical propositions have an equal applicability.

I think it is probably true that we often do not depend, for our assent to complicated reasonings, on anything like full "realization in succession of the actuality of the relations and operations discussed"; but I cannot admit that such reasonings do not refer to objects of experience or of thought. Unless the terms did refer to something other than themselves, we could never assert *S is P*, or $x = y$.

I unfortunately know nothing either of Pascal's theorem or of the intersections of two conics; but I think that in the case of the individual isosceles triangle, my intuition that the equality of angles at the base is inseparably connected with equality of sides, gives me ample ground for believing it to be "mathematically certain" that every isosceles triangle has equal angles at the base; it is self-evident that the one characteristic cannot exist without the other. That the isosceles triangle in question, if put under a microscope or tested by some micrometer, might turn out to be not "really" isosceles, seems to be a perfectly

irrelevant consideration; and I have never been able to understand the stress laid upon it by acute thinkers. It is because the triangle is *as far as I can perceive* isosceles, that I intuit it to be *as far as I can perceive* equal-angled.

It has, I believe, been already explicitly recognized by certain logicians that a "symbolically" proved conclusion need not give any actual information about "real things." Indeed some go further; but I do not know that any have gone so far as to say that it would not give any information about ideas—although perhaps this may be the logical conclusion.

Cambridge, November 10. E. E. CONSTANCE JONES.

Ice Crystals.

YOUR correspondent, C. M. Irvine (vol. xlvii. p. 31) will find letters on this subject in NATURE, vol. xxxi. pp. 5, 81, 193, 264, 480, and in vol. xxxiii. pp. 461, 486.

Prof. (?) McGee's letter at p. 480, of vol. xxxi., gives a list of communications on the same subject in earlier volumes.

B. WOODD SMITH.

The Late Prof. Tennant on Magic Mirrors.

SEVERAL scientific friends tell me that the late Prof. Tennant, the well-known mineralogist, published some twenty or twenty-five years ago a small pamphlet on Magic Mirrors. Failing to find a copy even in the library of King's College, I invite the readers of NATURE to assist me to discover one.

SILVANUS P. THOMPSON.

City and Guilds Technical College, Finsbury, November 15.

On a Supposed Law of Metazoan Development.

UNDER the title of "The Relations of *Larvæ* to Adult Forms," I recently read a paper before Section D at the Edinburgh meeting of the British Association. The subject dealt with was of so extensive a nature, and the time available was so limited, that I fear much that was said must have appeared vague and ill-founded, if not entirely incomprehensible. The material of the essay had, indeed, been prepared with the intention of devoting at least an hour to its delivery: as it happened, I found myself under the necessity of cutting out whole passages of my notes whilst speaking.

The few lines of the report in NATURE (vol. xlvi. p. 404), convey a very inadequate idea of what I aimed at proving in the paper, and hence I am tempted to offer a fuller account to the readers of this journal.

The subject of the essay furnishes a problem which must interest every embryologist, even though he should reject the conclusions to which observation and reflection have led me.

In working out the complete paper so many novel and confirmatory points have been met with, so much of importance in the writings of the older embryologists, and more especially in the memoirs of Johannes Müller on the Echinoderm larvæ, has been unearthed, that an extension of the original plan of the work has been rendered necessary.

My conclusions, moreover, are so much in conflict with prevailing doctrines that any haste in producing the full argument would be unpardonable, although a preliminary sketch by way of clearing the ground may be justifiable. On a subsequent occasion an attempt would be made to show how the researches of recent years had, with a few notable exceptions (such as the work of R. S. Bergh, J. Kennel, and N. Kleinenberg), tended away from rather than in the direction of a recognition of the fundamental fact of an alternation of generations as underlying Metazoan development, in that they had been concerned, for example, with unnecessary attempts at homologizing the "mesoderm" and its mode of formation throughout the animal kingdom.

If the facts in support of my case should not be as complete as the published researches of the last thirty years on the ontogeny of very many animals might lead one to anticipate, the circumstance would have an obvious explanation.

With the death of Johannes Müller—a man whose brilliance as an embryologist was only surpassed by his greatness as an anatomist—there closed one chapter, and that one of the finest, in the history of comparative embryology. What influence the publication of "The Origin of Species" had upon the subsequent progress of the science is too well known to need further expatiation here. The pernicious search after pedigrees, initiated by Haeckel, led to an era of activity during which every fact with no apparent bearings on phylogeny was ignored. As a consequence the work of Müller on the Echinoderm larvæ and the essay of Steenstrup on "Alternation of Generations" became more or less mere curiosities in the history of the science. With little exception embryological speculation of the past thirty years has been naught else than a pursuit of will-o'-the-wisps.

It behoves us now to revert to the path along which Johannes Müller laboured.

My own embryological conclusions, like those of contemporaries, have not hitherto been influenced by the *embryological* works of Müller; for it was not until after my paper had been read that a first study of the Echinoderm memoirs convinced me how nearly he had anticipated what follows.

Before passing to the subject, one further remark may be permissible. Owing to lack of time when reading the paper, no opportunity offered itself for pointing out the analogy which obtains between the suggested mode of Metazoan development and the accepted fact of an alternation of generations in the life-histories of all plants above the lowest Thallophytes. Furthermore nothing was said about the mode of formation of the "mesoderm" in certain cases as one or more outgrowths of the endoderm; although the writer was fully alive to the explanation which from his standpoint could be offered. This and other questions of a like character would receive consideration in the complete paper, in which it would be demonstrated that such things and processes need be neither "palingenetic" nor "cœnogenetic," but that the analogy of the formation of imaginal discs in *Insecta*, or in the *Pilidium* of the Nemertine, ought to suffice to account for them. As an instance, the formation of the mesoblastic somites in Amphioxus as evaginations of the endoderm may be only a mode in which certain parts of the adult are in that particular case laid down upon the larva.

And now, after this digression, to return to the question under consideration. Two modes of development have long been distinguished, viz., *larval with metamorphosis* and *fœtal and direct*. Cases are known in which there subsists no homology between the larva and the adult, and even such in which the larva (*Bipinnaria asterigera*) is said to exist apart for a time after it has given rise to the Echinoderm. In many such, moreover, the sole larval organ carried over to the adult is the alimentary tract, all other organs of the larva, such as nervous system, sense organs, locomotor and excretory organs, mouth and anus, &c., being replaced by new formations in the adult. The new organs are thus not homologous with those of the larva; indeed, neither as a whole nor in its parts is the larva the homologue of the adult form; but the latter arises upon the former by a mode of asexual generation.

The birth of the Nemertine on the *Pilidium*, and that of the Echinoderm upon the *Pluteus*, or upon the *Bipinnaria asterigera*, may be cited as examples, and the question may now be asked, What becomes of the larva when (α) food-yolk is more or less abundantly acquired, and (β) when uterine development is initiated? Does the larva really disappear? Anticipating the sequel, it is asserted that the larva never vanishes from the development, but is always present in more or less disguised form. In all cases the adult or imago would appear to arise upon it just as is so obviously the case in the examples previously cited.

In the complete paper the modifications of the process throughout the Metazoa would be considered; in this place generalities alone can be dealt with. If the larva be laded with food-yolk it becomes transformed into a more or less obvious *blastoderm*, upon which the *imago* or mature form takes its origin. Certain of the larval organs—such as those of locomotion—may then disappear, but others, such as the larval excretory and nervous mechanisms (*e.g.*, *Hirudinea*, according to Bergh's researches, *Ichthyopsida* from my own work) would persist. Considerations of space do not permit me to enter fully into details regarding Molluscan development. The published work on this group furnishes one with useful material in support of my case; and the group is an interesting one in connection with this question of the relation of the larva to a blastoderm. In the *Mollusca* one can readily find all gradations from cases in which the adult is gradually substituted for a pelagic larva (*Patella*), through those in which the larva is somewhat burdened with food-yolk (*Buccinum*), to others, finally, in which there is a large yolk-sac and a blastoderm, on which the adult form arises (*Cephalopoda*). Incidentally I may remark that it was the study of some *Buccinum*

larvæ (*Veligers* with large yolk-sac) three years ago, which first afforded me a key to the solution of the problem of the relation of the larva to food-yolk.

The *Arthropoda* are an important group, for larval forms widely prevail, especially, as is generally admitted, in the lower forms.

The nature of the *Nauplius* is too big a question for discussion here, but Dohrn's conclusion that it is a transformed worm larva (*i.e.* one with *Arthropod* characters) appears to me to represent the truth. Two of the laws governing developmental processes appear to be that larval organs may be transferred to the service of the adult, and (more usually) that adult organs may become larval, or, as thay may be termed, *adaptational larval organs*. Numerous instances of both these could be cited, and the three pairs of appendages in the Nauplius furnish us with a case in point.

In the development of *Mysis* there is an example of the conversion of the *Nauplius* larva, typically represented in the allied *Euphansia*, into a blastoderm upon a yolk-sac.

I venture to attach most weight to the application of the principle to the *Vertebrata*, for it is there that my own work has chiefly lain, and it is undoubtedly the obstacles offered by the phenomena of Vertebrate development which have hitherto prevented the enunciation of the "law of development as an alternation of generations." Larvæ are so commonly encountered among the Invertebrata that the wonder is that no one has inquired why they are so rare, in any guise, in the *Vertebrata*.

In this latter division of the animal kingdom it becomes necessary to approach the problem previously stated as to the fate of the larva when uterine development is initiated.

It may firstly be noted that larval forms, equipped with many adaptational larval organs, are to be encountered in cases with complete segmentation and but little food-yolk, *e.g. Marsipobranchii*, *Ganoidei*, and most *Amphibia*, while a blastoderm on a yolk-sac is characteristic of *Elasmobranchii*, *Teleostii*, and *Sauropsida*, in which a larva, according to the common acceptation, would not be very obvious.

In all these cases, however, larval organs can be proved to exist, and, most important of all, there is a well-marked larval nervous system, which, while not certainly known to persist in any adult form, has been proved to degenerate during the ontogeny of all the oviparous *Ichthyopsida* as yet studied. This apparatus is certainly neither a part of the adult nervous system nor homologous with the latter. For an account of this mechanism the reader may be referred to the papers cited below.[1]

Among other larval structures referred to when reading the paper, the curious degenerating cells on the blastoderm of *Pristiurus*, to which Prof. Van Wijhe once drew my attention, and the knob on the blastoderm of *Torpedo*, as shown in Ziegler's beautiful models of the embryos of this form, and as described by H. E. and F. Ziegler in the *Archiv für Mikroscopische Anatomie*, Bd. xxxix. p. 85, deserve mention.

The yolk-sac viewed as part of the larva would require detailed and extended consideration.

It is gradually broken down by some ferment action on the part of the so-called merocytes,[2] which may possibly represent degenerating cells of the larva. Only towards the close of life in the egg-capsule does the yolk appear to be digested by the alimentary tract of the Elasmobranch. In some reptiles, according to Hans Virchow, the remains of the yolk-sac would appear to be cast off.

In the discussion on my paper, one speaker, a personal friend, hinted that I had been led to look upon the yolk-sac as part of the larva from having followed some stray ends of "larval nerve fibres" on to that structure. I had to confess my regrets that at that time I was unable to lay claim to any such observation; indeed, that having cut my embryos of *Raja batis* without any part of the yolk-sac appended, it had never occurred to me that the fibres described might pass to the yolk-sac. Quite recently it has been seen that at any rate some of the larval "subepiblastic nerves" of the *Anat. Anz.* paper *do undoubtedly make their way to the surface of the yolk-sac, lying just beneath its epiblastic covering.* That a further confirmation of my conclusions is to be found in this observation goes without saying.

[1] J. Beard: "The Transient Ganglion Cells and their Nerves in *Raja batis*. *Anat. Anz.*, 1892, pp. 191–206; and also, "The Early Development of *Lepidosteus osseus*," Proc. Roy. Soc. London, vol. xlvi. 1889, pp. 115–118.

[2] It is to H. E. Ziegler that we owe most of our knowledge of the way in which these merocytes, in their own degeneration and death, cause the elements of the yolk to become fit for absorption and assimilation.

Some three years ago, when considering the "Inter-relationships of the Ichthyopsida," at a time when this larval question was prominently before me as a fascinating puzzle, I thought that the larva disappeared above the *Ichthyopsida*. I was led to this conclusion by reliance on the accepted belief that larvæ are only met with in aquatic animals, more particularly in marine forms, and by the apparent absence of a larval nervous system above the *Ichthyopsida*. My recent studies and the work of Froriep and Robinson have taught me that this was erroneous.

The larva never disappears, however much it may undergo degeneration.

It may even be doubted if there are not traces of the nervous system of the larva in the ontogeny of the *Amniota*, for there appear to be certain observations of Froriep on reptiles which may admit of interpretation in this sense, and my friend, Dr. Arthur Robinson, tells me that he believes he has found traces of it in certain Mammalian embryos. In mammals, as will be seen, the larva must be regarded as an internal parasite, and like such it would yield up its chief organs. Some remains of its nervous system may, however, persist, as I have proved to be the case in *Mustelus vulgaris*, where the larva is almost as parasitic as in the Mammal. The *Amnion* of the higher Vertebrata is probably also a larval structure with analogies to the organ of the same name in *Insecta*, in the *Pilidium* development, &c., as Kennel had previously insisted. It would appear to me to be a membrane conditioned by the way in which the adult is formed upon the larva.

Another important larval structure is the yolk-sac placenta of *Mustelus lævis* and of many mammals.

In the latter the importance of this organ during a long period of fœtal life has been proved by Hubrecht and Robinson.

The yolk-sac placenta may be explained as due to the fixation of a parasitic larva; indeed, in mammals the larva has become a fixed internal parasite in the uterus, and its mode of life, like that of all internal parasites, leads to great degeneration.

In this connection it may be insisted that it would be contrary to all that we know concerning the effects of the parasitic mode of life to suppose that a form might become a fixed internal parasite, and subsequently becoming freed from its host, attain to a higher grade of organization. Yet this is what we must believe to hold good, if the current views of mammalian development be accepted as correct. From my standpoint, on the contrary, the larva may become a fixed internal parasite, and none the less there may arise upon it a more highly organized and, when fully developed, free-living form, the Mammal.

Witness must be borne to the circumstance that Müller, Kleinenberg, and Kennel have already recognized that in some few divisions of the Invertebrata the mature form always arises upon a larva.

In such groups as the Echinoderms an alternation of generations is now an obvious explanation of the facts, and when so magnificent an investigator as Johannes Müller proved this nearly fifty years ago, one asks, in vain perhaps, why modern embryologists, like Korschelt and Heider in their otherwise admirable "Entwickelungsgeschichte," ignore it. The "recapitulation theory," and the question concerning the nature of the mesoderm have overshadowed the fact and concealed the recognition of an alternation of generations. But the so-called "law of ontogeny" itself is no explanation of the riddles of embryology; at most the recapitulation hypothesis holds for the development of organs, not of organisms.

So far as the facts are available, Metazoan development appears to me to be by means of an alternation of generations, in that from the fertilized egg there arises an organism, the larva, upon which, in one way or another according to the circumstances of each case, a new form, the adult or imago, takes its origin.

In 1855 the veteran zoologist, P. J. Van Beneden, wrote:—"*La génération alternante est un phénomène qu'il faut chercher à faire rentrer dans la loi commune de la reproduction et non pas laisser comme une exception dans la science.*"

In this essay an attempt has been made for the first time to prove that it is "la loi commune de la reproduction" in Metazoa,[1] and in concluding I cannot do better than echo the beautiful aphorism of Gœthe, which in a similar connection has already been commented upon by Steenstrup and Von Baer:—

"*Die Natur geht ihren Gang, und was uns als Ausnahme erscheint ist in der Regel.*"

J. BEARD.

[1] It is not assumed that all the phenomena classified as "alternations of generations" are alike in their nature.

EXPERIMENTS ON FOLDING AND ON THE GENESIS OF MOUNTAIN RANGES.[1]

Method of Investigation; Folding at Different Levels.

DEFORMATION is represented in an exact manner, if we note the movements executed by certain points, and the position of these points before and after deformation. I divide the surface of sediments into squares (scale = 0·1m.), and this division passes in vertical direction through the whole system, so that every stratum is divided into prisms or cubes of known dimensions and positions. At every moment of deformation we may note the movements of any point or line, and the deformation of any square or prism. Especially the deformations of the surface and of normal-profiles is important. The position (orientation) of prisms must agree with the direction of pressure.

FIG. 1.

FIG. 2.

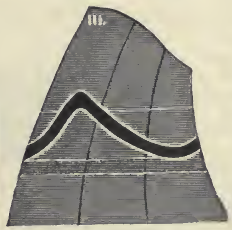
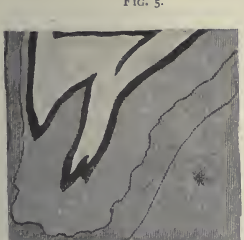
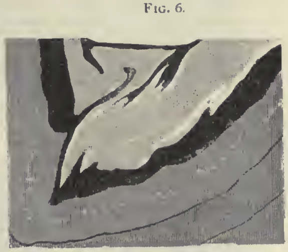
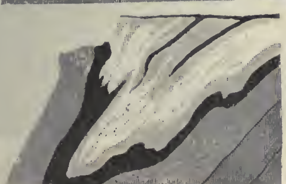


FIG. 3. FIG. 4.

FIG. 5. FIG. 6.







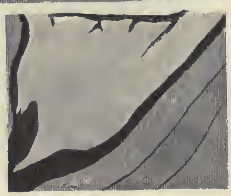


FIG. 7. FIG. 8.

I employed in every case muddy material (clay, plaster of Paris). Example: We note the position of prism I. in Fig. 1, and its position and deformation are noted in Fig. 2; I. is pushed forward and deformed into I.x. B = the "Basal plane," is parallel to the base or surface. No = Normal plane, is situated vertical and in the direction of pressure. L = Longitudinal plane, vertical and at right angles with No, agrees with extension of strata.

N = normals, *i.e.*, perpendicular scale-lines.

Explaining experiments: The sediments I., II., Fig. 3 (exp. 203, clay with a layer of plaster) are subjected to lateral thrust. The higher parts are more moveable and get deformed more than the lower strata.

I. goes to I.x, it is compressed and elevated; II. in contact with the wall is elevated a little (to x). The dark middle stratum I. produces a flat fold. In Fig. 4 compression and elevation is more intensive. The normals N (originally vertical lines) are deformed into curves.

When at the surface very plastic material dominates (mud), the surface after deformation remains flat, whereas in the deeper parts intense folding may have taken place. If we push a muddy mass, covered by plastic layers, the latter get folded, whereas the deep parts are only thickened.

The movements and deformations of N (normal profile) are of especial importance.

Fig. 5 (exp. 292), paper between muddy strata. The direction and deformation of normals show the typical movement of strata in each case.

In Fig. 6 a plastic layer (white) lies between muddy sediments. After the deformation only the white layer is folded.

In Fig. 7 folding towards the deeper parts is more intense, but the muddy surface remains flat. In all these cases strata get thickened. The thickness measured in a fold-chain does not correspond to the original thickness. The strata of the Appalachian Mts., having to-day a thickness of 10 km. in a certain section, originally had different dimensions. If measured along the fold-limbs the number is by far too small, as here the strata are rolled out; in the synclines, on the contrary, strata appear much thicker than they were at the beginning.

If plastic sediments are driven by their own weight, *i.e* if they *glide* over an inclined plane against an obstacle.

[1] Extracted from *Geologische und Geographische Experimente*, by Dr. E. Reyer. 1 Heft: Deformation und Gebirgsbildung. Leipzig, 1892. See also "On the Causes of the Deformation of the Earth's Crust," by the same Author. (NATURE, vol. xlvi. p. 224.)

there occurs a deformation, as in the case of lateral pressure. Deformation in the first case is greatest near the obstacle.

Anticlinal Rupture, Pinch-folds, Squeezing, Pseudo-eruptive Processes.

Pushing produces compression. In the anticlines tension effects rupture. In the fold-limbs plastic material is squeezed, rolled out, and pushed towards the clines (synclines or anticlines).

In the synclines of great dimension plastic material is pushed together and pinch-folds result.

Passing over some of the experiments which illustrate the dislocations described by Heim and Margerie we come to more complicated examples.

Figs. 5–8 show "pinch-folds" in very plastic material, which are spread and thrust over, so that they form a flat bottom in the syncline.

Other experiments illustrate a pinch-fold with ruptural deformation. Usually the intense deformation is confined to the district of the pinch-fold; in very plastic material and under variable pressure the stratum in every part gets greatly altered. If we divide the strata into differently coloured prisms we see in each profile at once the deformation at every point. Often deformation is so intense that we may denote it as kneading.

The deformation shows how a vertical dyke gets influenced by folding.

If a plastic stratum is inserted between rigid strata, the former often gets injected into ruptures of the rigid sediments; mud-dykes, pseudo-eruptive processes (Reyer, "Theoret. Geol." p. 330).

Movements of Normals and of Waves. Overthrust, Thrustplanes.[1]

In a fold-chain the higher masses are pushed over the lowland, which does not yield sufficiently. The result is an overthrust, often combined with pinch-folds, Fig. 11 (exp. 207). The inverted strata dip against the direction of the push.

Fig. 9 = original thickness of strata. In Fig. 10 folding begins. Fig. 16 last stage. Normal measure at the base = 1 dm.

In most cases shifting occurs between the strata, especially in upheaved strata, and we see gaping fractures, which cross a stratum and then follow again the planes of stratification (intrusive sheets).

The gliding movement may sometimes cause an extrusion.

Fig. 12 plan, and section Fig. 13 (exp. 278).

An overthrust-fold is nearly squeezed off (compare position of normals). An intense thrust generates ruptures, and the strata glide in the form of scales over the lowland.

Fig. 14 (exp. 242) a fault in the base, over which a complex of sediments glides; the lowland sinks and the higher masses now push with increased force towards the plain ("Vorfaltung": *Suess*).

Squeezing and Tearing, Deformation of Included Masses.

Squeezing and tearing often occur in regions of great difference of tension or pressure. In the anticlines strata are torn, the direction of ruptures is converging towards the axes (axipetal direction), in the limbs there occur squeezing and tearing.

[In the latter part of his memoir, Dr. Reyer shows how his experimental methods may be applied to the explanation of such complicated questions as very complicated overthrust faults, the appearances presented when much folded and faulted strata are subjected to erosion, the occurrence of undisturbed tracts associated with much folded ones, and the formation of lake-basins.]

E. REYER.

FIG. 9.

FIG. 10.

FIG. 11.

FIG. 12.

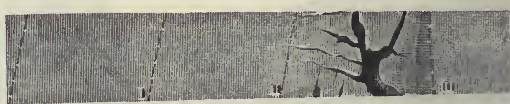


FIG. 13.

FIG. 14.

[1] Compare the excellent experiments of Forchhammer (Sanddruck, 1883), Cadell (NATURE, vol. xxxvii., p. 489). Those authors experimented with powdery material, whereas I operate upon plastic materials.

GALILEO GALILEI AND THE APPROACHING CELEBRATION AT PADUA.

ALTHOUGH Galileo began his career as a teacher in Pisa, and occupied for three years the Chair of Mathematics there, and was inscribed until his death in the list of the teachers of that University, nevertheless the University of Padua was the one to which from the beginning he had aspired, and in which he exercised with the greatest efficiency his powers as a man of science and

a lecturer. Now the University and citizens of Padua desire to celebrate the tercentenary of the day on which he delivered his first lecture.

When elected by the Venetian Republic to the Chair of Mathematics on September 26, 1592, he asked to be permitted to delay the beginning of his lectures in order to prepare his inaugural oration, and to attend to some domestic duties which required his presence in the country; thus it was December 7 when he first occupied the professorial chair. This date is confirmed by a letter, written from Padua to Tycho Brahe, and published by the latter in his celebrated "Astronomiæ Instauratæ Mechanica," and Galileo's chair is amongst the most precious relics preserved by the ancient and famous University. A week later he began regular lectures, which he continued to give for eighteen years.

In the ancient archives of the University the rolls of the time when Galileo taught are in a great measure preserved, and from these we learn that, in accordance with what was prescribed by the statutes, he alternated astronomical teaching with that of Euclid and the mechanical questions of Aristotle.

The didactic activity of Galileo was not altogether confined to public teaching; it was extended, in conformity with the prescriptions of the statutes, to private teaching. How much influence he exercised in this manner is easily seen from his autographic records which have come down to us. The importance of these private lessons will appear all the greater when we reflect that they dealt not only with the subjects discussed in public, but with matters connected therewith. From contemporary documents we perceive with what precision all such subjects were taught by Galileo: the use of the geometrical and military compass, fortifications, Euclid, perspective, mechanics, geography, arithmetic, geodesy, and cosmography. As to the students, they were for the most part foreigners, namely, Poles, Germans, Danes, French, and Flemings. In the lists of private scholars we find an "illustrious Englishman"—very probably Richard Willoughby, who was vicar of the University of Law and Councillor of the English nation. In his honour a stone on the wall of the University is still preserved, and, a still greater honour, a copy of the famous "Difesa" is dedicated to him with Galileo's autograph. Two Scots should also be particularly mentioned as amongst Galileo's pupils; these were John Wodderborn, who wrote a confutation of the libel of Horky against Galileo, and dedicated it to Henry Wotton, the English ambassador at Venice; also Thomas Segget, Councillor of the Scots nation, in whose "Album Amicorum," now in the Vatican library, there is also an autograph of the great philosopher. It was Seggett who received from Kepler a copy of Galileo's "Sidereus Nuncius," and who in the appendix to the "Narratio" of the same Kepler published the epigrams containing the famous "Vicisti Galilaee."

Besides the ordinary public and private lectures, Galileo held in the University some special public lectures, of which we may mention those upon the new star of October, 1604, and those in which he announced his astronomical discoveries.

Every one tried to render Galileo's stay in Padua as pleasant to him as possible. His freedom in teaching was absolutely complete, and the strong arm of the Venetian Republic defended the professors of the University from the power of Rome. In Padua, from the first, Galileo was received with the greatest kindness; he found many faithful friends both in Paduan society and among the Venetian patricians. His salary was repeatedly increased, so that, after the presentation of the telescope, it rose to thrice the amount conceded to his predecessors. Galileo came to Padua at the age of twenty-eight and remained there during the eighteen years which were the best of his life, those in which he showed the greatest scientific fertility, and in which he prepared the way for all his future labours. We have now reached the completion of the three centuries since Galileo began his teaching in Padua, and the University naturally considers that the anniversary should not be allowed to pass without honourable notice.

It is fitting that a celebration relating to the work of a man of science of the highest rank should have a truly national character. The King of Italy has therefore associated himself with the movement; and the Universities, the polytechnic institutions, and the most celebrated academies of the world have been invited to send delegates. Already the Universities have in great number responded to the appeal. Mr. J. Norman Lockyer will represent the Royal Society of London, and Mr. George Howard Darwin the University of Cambridge.

As once scholars from every part of Europe came to Padua to hear the celebrated master, so now from every part of Europe the most celebrated come to honour his memory.

ANTONIO FAVARO
(Director of the National Edition of Galileo's Works).

A NEW METHOD OF TREATMENT FOR CHOLERA.

IN the *Times* of the 18th inst. there appears an account of a new method of treatment for cholera which, should it ultimately be proved to be founded on accurate observation and well-authenticated cases, gives results seldom, if ever, obtained by any other method during the height of a cholera epidemic. Before criticizing this new method let us see what are its essential features.

In cholera there are two main, and evidently different, indications for treatment: it is usually maintained that the primary etiological factor in the disease is the "Comma" bacillus, which under certain conditions is enabled to live and multiply in the human intestine. There, living as an anærobic organism, it thrives especially well if, through inflammatory reaction, certain of the albuminous constituents of the blood and lymph are thrown into the intestinal tract. From or in this favourable culture medium it is enabled to produce a most virulent and readily diffusible poison, which has not only a powerful local action, but also a power common to these micro-organismal poisonous products, of acting on the nerve centres. In this way, so long as the bacillus remains alive, the supply of exudation into the intestine is kept up by the local irritant action of the poison, this being accompanied by a rapid abstraction from the blood of its watery elements, and at the same time a supply of the powerful "toxine" is maintained and diffused throughout the body. Except in very severe cases, where the paralyzing effect of the toxine on the individual cells of the tissues is extremely rapid and well marked, an effort is made by these cells to destroy the bacilli and by the special secretory cells of the intestine, kidney, and other excretory organs to eject this poison from the body. Not only so, but if the poison can, like the bacillus, be confined to, and eliminated directly from the intestine, the bacillus soon becomes unable to live, and as it multiplies and produces its toxines it is killed off by the various agencies that are conspiring to destroy it.

Up to the present all conceivable methods of treatment have been tried, and almost every drug has been pressed into the attack on cholera, but the most successful and rational attempts have been those in which the destruction of the bacillus and its poison have been aimed at, especially if this has been accompanied by the use of means for promoting the rapid secretion

and excretion of the poison from the body. Here as in the specific infective diseases generally our want is an antiseptic that will help to kill bacteria, directly or indirectly, and that will not damage, but will even give healthy stimulation to the tissue cells.

In this new method of treatment it appears to be claimed that in certain periodate salts we have substances which act not only on the bacillus (as bactericides) in the alimentary canal, but also directly on the "toxines," bringing about their oxidation into less complex and more stable non-poisonous substances, which can be readily excreted by the kidneys, or may be got rid of directly from the intestineal tract. It is also claimed, but apparently with very little reason, that the periodate salts have some direct action on the nerves; this, however, is mere conjecture, and the arguments offered in support of this hypothesis are far from convincing. In the *Times* article it is stated that "there are two principal drugs employed—the crystals of periodate" (of what?) "which are powdered, and a periodate of iron. The last-named is used in such cases as demand an extra strong nerve or cardiac stimulant treatment, and where there are severe neuralgic symptoms. The first is used in several ways: first as a powder to disinfect the alimentary tract; second as a plain water solution, prepared by boiling copiously, and used as a beverage by patients to wash out the stomach in severe vomiting, which abates as soon as the walls of the stomach begin to absorb the fluid, whereby the nervous energy is stimulated, in from two minutes to an hour or two; for transfusion under the skin, and, in cases of collapse, into a vein, for restoration of the suspended circulation of the blood; third, an acid solution of the powdered crystals of much greater strength than the plain watery preparation is found to stimulate the liver and kidney and gall bladder, promoting a free secretion of bile."

It is supposed that by this treatment the body is flushed and sweetened as it were, and so far the treatment would be rational enough could it be thoroughly carried out. Far greater reliance might have been placed on the evidence put forward had the initiator of this treatment been content to place on record facts, instead of attempting to formulate a theory for everything, as his theories whilst giving evidence of his undoubted enthusiasm, indicate only too plainly that where he gets beyond the use of the test tube he is compelled to draw largely on his imagination for many of his facts and most of his explanations.

As regards the percentage of recoveries mentioned, it must be remembered that towards the end of an epidemic the fatal cases always form a much smaller proportion of the total cases than during the earlier stages of the outbreak. The people most susceptible to the attack of the disease, *i.e.* those with damaged hearts, kidneys, and lungs, have already succumbed, the weaklings have been cleared out of the way, and but the fittest and comparatively well-nourished remain. Attempts have been made to ameliorate the wretched surroundings of those most prone to take the disease; the poor are better fed and better able to withstand the ravages of the cholera organism; the "cholera fright," at first a most potent factor in the preparation of patients for cholera, has to some extent subsided; the cases are not only much less numerous, but they are of a milder type and a less fatal character. Then, too, after the first few batches of patients come in (amongst which the mortality is always extremely high) there ensues a kind of panic amongst the authorities, and the treatment consists of little more than placing the patient in a ward along with others suffering from the same disease, in order to get them away from their healthy companions; other treatment is for long of the most meagre description, and it is only when hygienic conditions have been improved, mode of transport organized, and hospital accommodation arranged that the medical authorities have time to devote to the treatment of individual patients. As soon as patients do obtain such individual treatment and attention the percentage of fatal cases rapidly declines.

These periodates, analogous salts to the chlorates, are apparently the direct heirs to the qualities that at one time were ascribed to the chlorates, for which it was claimed that they had great power of supplying oxygen for the transformation of poisonous products in the body. It was found, however, that these chlorates when administered in large doses made their appearance in the secretions in a very slightly altered condition; not only so, but they exerted an exceedingly deleterious effect on the blood, reducing the hæmoglobin to methæmoglobin, and stopping the respiration and bringing about a fall of the blood pressure to zero. This periodate, which is apparently extremely insoluble except in acids, may be tolerated in small doses, but its physiological action, especially when administered in large doses, can scarcely yet have been studied.

As to the action on the kidneys through the nervous system, we have as yet little or no evidence that there is any direct action of the nerves on the secretion by the kidneys except through the vaso-motor system. It is usually maintained that the suppression of urine in cholera is due primarily to the extremely low general blood-pressure owing to the rapid abstraction of the fluid elements of the blood brought about by the passage of watery stools, but also in part to the irritative action on the secreting cells of the kidney of the cholera toxines, as a result of which secretion is more or less paralyzed. In order to overcome this stoppage of excretion by the kidneys, the practice of injecting warm normal saline solution has in recent epidemics been practised with some success, especially when boldly and repeatedly carried out. This treatment has the additional advantage that it not only supplies fluid to the parched tissues, but also increases the volume of blood on which the heart may contract and helps to wash away the specific poison. It is utilized to a very great extent in the new method described in the *Times*, but whether the periodates are better than common salt as a substance with which to raise the specific gravity of the warm water, yet remains to be determined. As yet the details supplied are far too meagre to allow of any definite opinion as to the value of this periodate treatment being arrived at.

It is fortunate that we have no cholera epidemic with us at present, otherwise we should have a right to complain that the *Times* has been made the medium through which what must be a very imperfect—and certainly from a physiological point of view—incorrect theory, has been presented to the public, and it will be well to await the exact accounts of those who have been entrusted with the carrying out of the treatment in the wards of the Seamen's Hospital, and the results of fuller chemical physiological, and therapeutic experiments, minutely detailed and recorded, before we allow ourselves to be buoyed up by hopes which, previous experience has taught us to fear, may be very summarily and completely dashed. We hope that we may have no opportunity of testing the value of this new treatment in England, but there is too much reason to fear that, abroad, opportunities in abundance will be afforded during next spring and summer.

How much of the success obtained in Hamburg is to be ascribed to the factors above mentioned, and how much to the careful treatment and nursing of confident medical men, inspired by the enthusiasm of the "inventor" or promoter of the "periodates," it is difficult to say, and we shall await with interest, but with well disciplined and chastened expectation, the report of the German doctors mentioned in the *Times* on the results of their observations.

NOTES.

MR. W. H. PREECE, F.R.S., has been appointed engineer-in-chief and electrician to the Post Office.

A CIVIL LIST pension of £75 per annum has been granted to Mrs. Dittmar, widow of Dr. William Dittmar, F.R.S., Professor of Chemistry in Anderson's College, Glasgow, in consideration of her husband's distinguished services.

THE Linnean Society, at its ordinary meeting on the 17th inst., adopted an address of congratulation to the Rev. Leonard Blomefield on the completion of the seventieth year of his Fellowship of the Society, he being the father of the Society, having joined it on November 19, 1822, and being now in the ninety-third year of his age. At the time when Mr. Blomefield (then Jenyns) became a Fellow of the Linnean Society, it was still under the presidency of its first President, Sir J. E. Smith; he was also an original Fellow of the Zoological Society, and is one of four survivors of the founders of the Entomological Society. He joined the British Association in the second year of its existence. Mr. Blomefield was Mr. Darwin's senior at Cambridge, was closely associated with him in his zoological researches until Mr. Darwin's death, and was one of his most frequent correspondents. His early bias towards the study of nature was due to his reading White's "Natural History of Selborne" while at Eton. This was then a very scarce book. Having borrowed a copy of it from a friend, being uncertain whether he should ever see it again, he copied the whole of it in manuscript with his own hand. The address of congratulation was moved by Sir William H. Flower, seconded by Mr. St. George Mivart, and acknowledged by the Rev. Geo. Henslow, a nephew of Mr. Blomefield.

THE following gentlemen have been appointed to form the Fishery Board for Scotland:—Mr. Peter Esslemont is Chairman, the other members being Mr. John Guthrie Smith, Sheriff of Aberdeen, Kincardine, and Banff; Mr. George H. Thoms, Sheriff of Caithness, Orkney, and Shetland; Mr. Dugald M'Kechnie, Sheriff of Argyle; Mr. William Boyd, solicitor, Peterhead; Mr. James Johnston, fish-curer, Montrose; Mr. William Anderson Smith, Ledaig; Professor Mackintosh, St. Andrews; and Mr. J. Ritchie Welch, St. Andrews.

THE Royal Microscopical Society will hold a *conversazione* in the Banqueting Saloon, St. James's Hall Restaurant, on Wednesday, November 30, at 8 p.m.

THE annual dinner of the Institution of Electrical Engineers was held on Friday evening at the Criterion. The president, Prof. W. E. Ayrton, F.R.S., was in the chair. Responding to the toast of the Learned Societies (proposed by the chairman in a humorous speech), Prof. G. F. Fitzgerald said that learned societies were never more flourishing than they were now. The co-operation of theory and practice had been the fruitful parent of nearly all the advances of the present generation. We had such enormous stores of energy at our service that almost immeasurable prospects were open for the material improvement of man's estate. Mr. Latimer Clark (past president) proposed "The Engineering Societies." He said these societies were in danger of being overlooked. They first perfected the steam-engine, then improved manufacturing implements, then the steam-boat. The engineering societies had done much more to promote the great prosperity of this country than the politicians who had so wickedly usurped the greater part of the credit. Dr. W. Anderson responded. The Chairman then proposed "Our Guests," with which he joined the name of Mr. Mundella, President of the Board of Trade, who exercised a sort of parental supervision over them all. No doubt sometimes there was a little disposition to grumble, as children did occasionally, at the form in which that fatherly affection displayed itself But, whatever their feelings about the Board of Trade, there was no doubt about their feelings with respect to its president. Mr. Mundella, in response, said that, whatever grievances the engineers might have against the politicians, his withers were unwrung. The Board of Trade might have given the electrical engineers some trouble: if so, it was not due to him. Mr. Latimer Clark had complained of the appropriation of all the credit of material progress by the politicians. Let them halve the difference. The politicians had, at all events, appointed Dr. Anderson. He was speaking to a comparatively young institution, but it was to one which was growing more and more and would advance to still greater degrees of greatness. The Board of Trade owed much to the electrical engineers, who had devised systems and methods of the utmost value. He believed we were now at the outset of a great advance in the science of electric lighting. Progress would be assured when they could assure shareholders of a reasonable dividend. Two millions had already been expended in the metropolis, and we might soon hope to overtake the United States and Continental countries, which were, he feared, still to some extent in advance of ourselves. The Board of Trade had no desire to hamper the progress of electricity by needless rules, and hoped that in this, as in all other branches, science would go on its beneficent course untrammelled by any unnecessary regulations. Sir James Sivewright, Commissioner of Public Works, Cape Colony, proposed "The Institution of Electrical Engineers," to which the president briefly responded.

WE print elsewhere an abstract of a most interesting paper on stability and instability of viscous liquids, read before the Royal Society, by Mr. A. B. Basset. It presents in a new way the various problems involved in the calming effect of oil poured on troubled waters.

PROF. J. E. HUMPHREY, of the Massachusetts Agricultura Experiment Station, is about to visit Jamaica for the purpose of making a study of the algæ and fungi of that island.

THE weather during the past week has, upon the whole, considerably improved; it has been mostly fine in the southern and eastern parts of the kingdom, but less settled in the west and north. Temperature has been decidedly lower, and over the central and eastern parts of England sharp frosts have been experienced. The distribution of pressure has been generally cyclonic over these islands, but over the west of Europe the anticyclonic has still held its ground. The eastern portion of England has been brought under the influence of both high and low pressure systems, being situated about mid-way between the cyclones which have skirted our western coast, and the anticyclone over western Europe. These conditions were accompanied by very quiet weather, with a good deal of local fog. On Sunday a depression, which passed along the Irish coast, caused southerly gales on that and following days in the south of Ireland and the English Channel, with very heavy rainfall in Ireland; the amount measured at Roche's Point on Monday and Tuesday mornings was nearly 2·5 inches. Towards the close of the period the European anticyclone was spreading westwards, and the barometer was high and uniform over Great Britain. For the week ended the 19th instant the official reports show that the rainfall was considerably in excess of the average over Ireland and the south of England. From the beginning of the year the deficiency in the latter district is 2·3 inches, and in the south-west of England 8·4 inches, or more than 23 per cent. of the average amount. Bright sunshine was

again very deficient over the whole of England and Scotland; in the south-west of England the duration only reached about 2 per cent. of the possible amount.

The *Pilot Chart* of the North Atlantic Ocean for November contains some interesting reports of the drift from some portion of the coast of the American continent to mid-ocean of a mass of forest growth resembling a floating island. It was first seen on July 28 in lat. 39° 42′ N., long. 64° 20′ W. On September 19 the *Roman Prince* reported it in lat. 45° 29′, long. 42° 39′ as "a clump of bamboos about 30 feet in diameter and 20 feet high." Between these two dates the little island drifted more than 1000 miles in an E.N.E. direction. The month of October was very stormy in the North Atlantic; from the tracks laid down on the chart several of the storms seem to have moved along very abnormal tracks, and this fact has probably some connection with the very severe weather experienced in this country. In the early part of the month a hurricane formed in very low latitudes, and passed over Trinidad on October 6 into the Gulf of Honduras, and possibly into the Gulf of Mexico. It is unusual for a hurricane to occur in such low latitudes in the North Atlantic. Very little fog was reported, and no ice south of the 50th parallel.

Several shocks of earthquake have been felt lately in the island of Ponza. On the evening of November 16, according to a Reuter's telegram, the walls of several houses were slightly cracked by one of these shocks, which was accompanied by subterranean rumblings. No one was hurt, but alarm spread rapidly among the inhabitants, half of whom took refuge on small vessels lying along the coast, while the remainder encamped on the beach.

The *Age-Herald* of Birmingham, Alabama, gave on October 28 an account of a great meteor which had been seen on the previous day to pass over that city and disappear in a south-westerly direction. We learn from the Mobile *Daily Register* of October 29 that at Gadsden a brilliant meteor was seen at the same time, that is, between five and six o'clock on the afternoon of October 27. It passed near the zenith. Two young men employed in the *Daily Register* office at Mobile saw at the same hour in the afternoon a bright meteor in the north-west. It was about 45° above the horizon. When it neared the western horizon it exploded like a sky rocket.

A male gorilla (*Gorilla gina*) has lately been acquired by the Berlin Aquarium. He is larger than any gorilla that has yet been brought to Europe. He is supposed to be eight or nine years old, and was for six years in the possession of a chieftain on the Gaboon. Captain Clarke brought him to England. The *Naturwissenschaftliche Wochenschrift*—which estimates the value of this "splendid animal" as not less than 10,000 marks—says he has not yet shown any very friendly feeling for man.

It appears from a report issued by the Board of Trade that the examinations and comparisons of the Parliamentary copies of the Imperial standards show that no measurable change has taken place in the length of the Imperial standard of measure. The Imperial standard pound weight appears, however, by comparison with the Parliamentary copies of the Imperial standard pound, to have decreased in weight since it was restored and legalized by the Standards Act of 1855. The amount of diminution in the weight of the Imperial standard pound would not be appreciable in trade, and had probably arisen before the year 1872, but the Board of Trade are taking into consideration the question of restoring this standard in the manner provided by Section 6 of the Act of 1878.

The South Australian Government has issued a full report of the proceedings of the Rust in Wheat Conference during its third session, held in March of the present year. Among the resolutions adopted by the Conference was one to the effect that a practical system for the production and distribution of rust-resisting wheats suitable to different districts should be immediately established, and that this system—subject to modifications needed by each colony—should be conducted on the following lines:—A central station for each colony for the preliminary testing of new wheats introduced into the colony, for the production of new varieties by cross-fertilization and by selection, and for the distribution of suitable wheats thus obtained to representative districts of the colony, to be there subjected to a sufficient test, and, if necessary, fixed in their characters by farmers and others competent for the work, and that such wheats as pass satisfactorily this test should then be distributed to the farmers around in such a manner and by such agency as would be most suitable to the conditions of each colony. The Conference will meet at Brisbane in 1894. It is hoped that in the meantime the various colonies will publish the results of the experiments which are to be carried on during the coming year.

Mr. Xanthus Smith, a well-known American photographer, has formed a high opinion of some of the work done in photography in England. "There is no doubt," he has lately said, "that the English photographers excel us Americans in landscape photography, and mainly for two reasons, the first being their appreciation of atmospheric effects, which is no doubt a result of their moist climate; and second, the extreme pains which they are willing to take in order to secure an effective picture." The *Photographic News* considers it "quite a comfort to record a statement like this, not because it praises English work, but because it acknowledges the pictorial effect often obtainable from a misty atmosphere." "Those who are ignorant of the subject," adds our contemporary, "invariably credit the alleged superiority of foreign photographs to the greater clearness of the atmosphere which is supposed to prevail outside the confines of Great Britain."

An interesting case of a wild rabbit living in an almost tame condition is recorded by Helen J. Murray in the current number of *Nature Notes*, the Selborne Society's magazine. Mrs. Paul, a fisherman's wife, living in a hut between Ardnahein Farm and the mouth of Loch Goil, deserves the credit of having achieved this result. The rabbit was brought in when very young by a cat, and reared by Mrs. Paul, from whose hand it still feeds. It now spends part of its time in the woods, and part on the low sloping roof of the hut among the pigeons, or at the door among the fowls. It is shy in the presence of strangers, but quite friendly to the fisherman's wife.

It seems that since the appearance of the Russians at Tashkend a beginning has been made there in the cultivation of the better kinds of tobacco. According to the *Journal of the Constantinople Chamber of Commerce*, quoted in the Board of Trade Journal, first trials were made by a commercial firm trading between Persia and China. The satisfactory result of this cultivation, due to the favourable atmospheric conditions and to the fruitful qualities of the soil, attracted many Russian imitators, and very soon the native population followed their example, so that the area of land devoted to the cultivation of tobacco now comprises sixty-three deciatines, and it is expected that it will not stop at that point.

The new number of *L'Anthropologie* contains an interesting article by M. Emile Cartailhac, on the Stone Age in Egypt. It is the first of a series of papers on the stone age in Africa. English readers will be glad to see that in this instalment M. Cartailhac does ample justice to some of the discoveries of Mr. Flinders Petrie, the value of whose work has also been fully

recognized lately in the German periodical *Globus*. Another good paper in *L'Anthropologie*, by M. Louis Siret, deals with the end of the Neolithic epoch in Spain.

PROF. MCINTOSH'S paper on the Scottish Fisheries, to which we referred at the time it was read at the Edinburgh meeting of the British Association, has now been issued as a pamphlet by Messrs. John Leng and Co., Dundee. The paper presents a clear and interesting account of the Scottish Fisheries, chiefly in their scientific aspects, during the decade 1882-92.

THE Cartwright Lectures, 1892, delivered by Dr. Henry F. Osborn, Professor of Biology in Columbia College, have been reprinted from the *American Medical Record*. They deal with "present problems in evolution and heredity." In the first lecture Prof. Osborn discusses the contemporary evolution of man; in the second, difficulties in the heredity theory; in the third, heredity and the germ cells.

THE Kansas University has started a "Quarterly," which is to be maintained as a medium for the publication of the results of original research by members of the University. In the second number, which we have just received, Mr. E. H. S. Bailey has an interesting paper on the Great Spirit Spring Mound. The Great Spirit Spring is in Mitchell county, Kansas, on a conical limestone mound 42 feet high, and 150 feet in diameter at the top. The pool itself is a nearly circular lake about 50 feet in diameter, 35 feet deep, and the water rises to within a few inches of the top of the basin. There is a level space on all sides of the spring so wide that a carriage can be readily driven round it. Within about 200 feet of the mound is a limestone bluff, which rises perhaps 20 feet above the level of the spring. Mr. Bailey suggests that the mound may have been made by successive deposits from the spring. Although the mound is plainly stratified, this need not, he thinks, interfere with his theory, as the water may have been intermittent in its flow. The rock is very porous, and on being ground to a thin section is shown to be concretionary in structure. It is of just such a character as might have been built up by deposition from the water, as it contains the least soluble constituents of the water. The process of solidification would be assisted by the silica in the water, forming insoluble cementing silicates. An analysis given by Mr. Bailey shows that there is abundant silica in the water for this purpose.

A PAPER presenting a revision of the species of Coryphodon, by Charles Earle, printed originally in a Bulletin of the American Museum of Natural History (vol. iv., No. 1), has now been issued separately. The recent expedition sent out by the American Museum of Natural History to the Bad Lands of the Wahsatch formation of Wyoming was successful in procuring some valuable Coryphodon material. The entire collection was placed in Mr. Earle's hands for identification and study. He has been surprised by the large number of species which have been proposed, and finds upon studying and comparing the types that a great reduction in the number of species should be made.

WITH a view to determining the phylogenetic position of mammalian hair, Herr Maurer has recently been studying the sense organs of the skin, feathers, and hairs, and their mutual relations (*Morph. Jahrb.*). His researches render more evident the profound difference that exists, both in early development and in later behaviour, between mammalian hair and feathers. Morphologically, they are to be regarded as quite different organs. Are the hairs, then, *sui generis*, or may they be brought into relation with other epidermis-forms? From studying the lower vertebrates, Herr Maurer considers that the skin sense organs of amphibia afford the ground on which hairs are developed. The complex relations of the root sheath of the hair allow thus of an easy explanation. Further, as to the relation of mammalia to other vertebrate groups, as indicated by forms of integument, Herr Maurer is of opinion that mammals become separated from Sauropsida and draw closer to amphibians, thus confirming a view based on other points of organization.

FLUORSULPHONIC ACID, $SO_2(OH)F$, has been isolated by Prof. Thorpe and Mr. Walter Kirman in the laboratory of the Royal College of Science, South Kensington, and an account of their experiments was given at the opening meeting of the Chemical Society, held last Thursday evening. When liquid hydrogen fluoride is brought into contact with sulphur trioxide a violent reaction occurs. The product of this reaction, provided any great rise of temperature is prevented by extraneous cooling, is now shown to be fluorsulphonic acid, a liquid behaving in many respects like the chlorosulphonic acid, $SO_2(OH)Cl$, discovered by Prof. Williamson. The preparation of fluorsulphonic acid was effected in the following manner:—A quantity of sulphur trioxide was first distilled from a glass apparatus into the receiver of a distillation apparatus constructed entirely of platinum. A quantity of the anhydrous double fluoride of hydrogen and potassium, HF.KF, more than sufficient to furnish enough hydrogen fluoride to combine with all the sulphur trioxide, was then placed in the retort of the latter apparatus, and the retort connected with a long condensing tube surrounded by a freezing mixture of ice and crystallized calcium chloride. The receiver containing the sulphur trioxide was finally adjusted to the condensing tube, and was likewise surrounded by a similar freezing mixture. Upon heating the retort the double fluoride of hydrogen and potassium was dissociated, and pure hydrogen fluoride (hydrofluoric acid) distilled over into the receiver and reacted with the sulphur trioxide. The excess of hydrogen fluoride was subsequently removed by means of a current of dry carbon dioxide, the receiver and its contents being warmed to a temperature of about 30° during the process. The fluorsulphonic acid thus prepared is a colourless mobile liquid, which possesses an extraordinary affinity for water, reacting, in fact, with that liquid with almost explosive violence. It fumes when exposed to air, and possesses a specific mildly pungent odour quite different from that of hydrofluoric acid. It may be distilled, with but slight decomposition, in a platinum apparatus, its boiling point (corrected) being 162°·6. The latter constant was determined by use of a specially constructed platinum distillation apparatus, in the neck of the retort of which was fitted a small platinum tube containing a little mercury, and in which the thermometer was immersed during the process of distillation, in order to protect it from the powerfully corrosive action of the vapour. The error introduced by the use of this arrangement was very slight, and was determined by distilling liquids of known boiling points. Considerable interest is attached to the relatively high boiling point of fluorsulphonic acid, inasmuch as it is several degrees higher than that of chlorosulphonic acid, which boils at 155°·3. It would appear as if this fact is in some way connected with the relatively high boiling point of hydrogen fluoride itself (19°), as compared with that of hydrogen chloride, which, as most people are aware, is gaseous down to comparatively low temperatures. The main products of the decomposition which occurs to a slight extent during distillation, are most probably sulphuric acid and sulphuryl difluoride, SO_2F_2, which latter compound Prof. Thorpe and Mr. Kirman shortly hope to isolate by a method similar to that by which Behrend prepared the analogous sulphuryl dichloride, SO_2Cl_2.

THE additions to the Zoological Society's Gardens during the past week include two Maholi Galagos (*Galago maholi*) from South Africa, presented by Mr. Luscombe Searelle; a Feline Genet (*Genetta felina*), a White-eared Scops Owl (*Scops leucotis*), a Tawny Eagle (*Aquila nævioides*) from Matabeland, South

Africa, presented by Mr. B. B. Weil; two Jackdaws (*Corvus monedula*, white var.) British, presented by Mr. Harding Cox, F.Z.S.; eighteen Deadly Snakes (*Trigonocephalus atrox*) from Demerara, presented by Mr. J. J. Quelch, C.M.Z.S.; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mr. J. Pettitt; a Blue and Yellow Macaw (*Ara ararauna*) from South America, deposited; four Lapland Buntings (*Calcarius lapponicus*), twelve Snow Buntings (*Plectrophanes nivalis*) European, six Cirl Buntings (*Emberiza cirlus*) British, purchased.

OUR ASTRONOMICAL COLUMN.

THE NEW COMET.—The following observations of the "Comet Holmes" are communicated to the *Comptes rendus* by M. Bigourdan, Paris Observatory:—

Date.	Paris Mean Time. h. m. s.	App. R.A. h. m. s.	App. Decl. ° ′ ″
Nov. 9	7 59 25	0 45 55·51	+ 38 19 25·8
9	9 28 6	0 45 53·46	+ 38 19 4·5
13	10 20 1	0 44 3·76	+ 37 53 6·2
13	10 46 32	0 44 3·17	+ 37 52 58·7
13	10 55 43	0 44 3·01	+ 37 52 57·9
13	11 10 49	0 44 2·71	+ 37 52 50·6
13	11 25 6	0 44 2·33	+ 37 52 48·6

On November 9 the comet was a large and bright nebulosity, perfectly round, and 5′·5 in diameter. It showed a central diffused nucleus, 10″ in diameter. A rather brighter portion of an approximately elliptic form appeared to extend from the nucleus in the direction $p = 127°$, its axes being 1′·5 and 30″ respectively. On November 13 the comet was only seen intermittently. It was 8′ in diameter and nearly round. The nucleus no longer occupied the centre, but had shifted towards the preceding portion. The elliptical region was 2′ by 30″, and in the direction $p = 116°·8$. To the naked eye it was easily visible, being as bright as the Andromeda nebula near it, but less easily distinguished, owing to its smaller apparent size.

The most recent elements and ephemeris have been obtained from observations made on November 9 at Karlsruhe, November 10 at Rome, and November 11 at Göttingen, and are given in *Astronomiche Nachrichten*, No. 3128, from which we make the following extract:—

Elements.

T = 1892 August 15·779 M.T. Berlin.

$$\left.\begin{aligned} \omega &= 300°\ 2'{\cdot}7 \\ \Omega &= 11\ 25{\cdot}9 \\ i &= 27\ 34{\cdot}0 \end{aligned}\right\}\ \text{M. Aequator, 1892·0}$$

$\log q = 9{\cdot}92222$

Ephemeris for 12h. Berlin M. Time.

1892	α	δ	log r	log Δ
Nov. 17	oh. 43·5	+37 32	0·2562	9·9734
,, 21	43·7	11	0·2688	0·0071
,, 25	0 44·7	+36 50	0·2810	0·0387

The comet can be easily picked up with a small telescope by knowing that it lies in a line joining the stars β and θ Andromedæ, about one-third of the distance from β.

MOTION IN THE LINE OF SIGHT.—The transformation of the great reflector of the Paris Observatory for the purpose of adapting it to the spectroscopic determination of radial velocities is described by M. H. Deslandres (*Comptes rendus* 20). Instead of having a flat mirror at 45°, a collimator was placed in the optic axis itself, and movable along it. The rest of the spectroscope, which contained three flint prisms and a camera, was enclosed in a rigid steel box attached to the upper ring of the telescope. In order to control the motion, the plates forming the slit were made of polished steel and slightly inclined, so as to throw an image of the sky down into an auxiliary telescope inside the tube, which was provided with a reflecting eye-piece. Thus the observer below, standing near the great mirror, was enabled to keep the star well on the slit. With this arrangement, spectra of stars down to the 4th magnitude could be obtained, 12 cm. long, in two hours. In the blue portion a displacement of 0·005 mm. indicated a velocity of 3·6 km. per second. The lines whose displacements were measured were those of hydrogen, calcium, and iron. 250 stars are within reach of the instrument. For α Aurigæ, with a comparison of 30 lines, the velocity was + 43·5 km. β Aurigæ is a spectroscopic double with velocities, on February 5, of − 84 km. and + 97 km. Venus, on April 12, had an actual velocity of 13·55 km. That indicated by the negative was 15 km.

"HIMMEL UND ERDE" FOR NOVEMBER.—The current number of *Himmel und Erde* contains many astronomical articles of interest. "The Heat in August, 1892" is the subject of an article by Prof. W. J. van Bebber. In this he brings together all the statistics of the temperature readings during the interval between August 11 and 25, and shows by weather charts the general state of the weather, such as wind, barometer, &c. The following few values, showing the highest temperatures recorded and extracted from the table mentioned above, may be of interest:—

Place.	Aug.	Temp. Fahr.	Place.	Aug.	Temp. Fahr.
London	23	80°·6	Cassel	17	96°·8
Oxford	23	77·0	Grünberg	19	102·2
York	23	73·4	Karlsruhe	17	96·8
St. Petersburg	26	86·0	Bamberg.........	18	100·4
Stockholm	26	82·4	Constantinople	21	100·4
Paris	18	95·0	Madrid	16	107·6
Biarritz	16	107·6	,,	17	107·6
,,	17	104·0	Rome	17—21	93·2
Brussel	18	95·0	Lagouat	23	105·8

Dr. J. Scheiner, on "Astronomy of the Invisible," deals with the discovery of the dark companions of Sirius and Procyon. He commences with an historical sketch of the study of the proper motions of the fixed stars and leads up to the most modern observations describing the results obtained with regard to Sirius and Procyon. Prof. Barnard, with the help of two excellent woodcuts, explains the working of the great Lick refractor. To prepare the instrument for micrometric work, he says five minutes is required; but for photographic work ten minutes is necessary, as a photographic correcting lens has to be adjusted to compensate for the difference between the photographic and optical focus; the large spectroscope absorbs nearly half an hour's work before it is ready for observation.

OBSERVATIONS OF PERSEIDS.—During the August display of the Perseids it has been noticed that in addition to the principal radiant point several minor ones have been observed, which although not very far distant from the primary one, are still far enough to suggest that they belong to another swarm of particles following a different track in space. The orbit, which the particles in the main follow, corresponds, as is well known, to that of the comet of 1862 III., and M. Bredikhine has suggested that the particles producing these minor radiant points belong really to the same swarm, only have either been acted on by external forces such as the perturbations of the major planets, or have been projected from the comet itself at different periods.

With the intention of bringing some facts to bear upon this idea, M. Puiseux, in the *Bulletin Astronomique* for October, gives the results of his observations made in August of last year, which seem to confirm those of M. Bredikhine in several points of view.

His method of observation was simply to chart down on a large celestial globe the positions of the trails as observed. A glance at this globe, after 199 positions had been so recorded, indicated that the area of radiation occupied a considerable surface, and extended principally in the directions of right ascensions, that several distinct centres of concentration were observable, and that the same radiant points, in general, manifested their activity at the same time, *i.e.*, on the evenings of August 10, 11, and 12, and some on August 7. In the table accompanying this paper M. Puiseux shows that no less than fourteen different centres of radiation were observed. Table II., which we produce here, contains the essence of the whole work, and shows the positions of the radiant points in question, together with the corresponding elements of the orbits deduced. It must be remembered of course that their values cannot be very accurate, owing to the difficulty of observation, but the results are nevertheless interesting. The different radiant points are denoted by A, B, C, &c., while α and δ represent

their right ascension and declinations; the other nomenclature is that usually adopted in cometary computations.

	α	δ	l	b	☊	i	q	ω
A	44°·5	49°·1	57°·1	30°·7	138°·6	127°·3	0·9643	296°·2
B	41·3	46·7	53·8	29·1	138·0	130·3	0·9836	302·3
C	47·3	39·7	56·0	21·2	139·0	143·6	0·9674	297·8
D	62·7	60·6	73·2	38·7	138·5	107·1	0·8046	265·6
E	52 5	53·4	64·3	33·2	138·1	120·6	0·8839	277·9
F	35·3	65·8	60·0	47·9	138·7	99·1	0·9759	298·9
G	30·0	43·4	44·0	29·1	138·4	130·7	0·9982	330·3
H	105·3	60·9	99·4	38·0	138·7	79·1	0·5145	230·2
K	19·5	28·4	29·0	18·6	138·7	144·3	0·7495	19·2
L	5·3	67·0	45·8	56·1	138·6	87·9	1·0028	322·3
M	118·5	53·2	109·6	31·7	138·7	64·0	0·3811	215·0
N	314·7	67·4	23·4	72·9	137·9	62·4	0·9872	330·8
O	323·5	50·1	355·0	58·8	138·7	63·1	0·8402	5·7
P	14·0	37·4	28·5	28·7	138·5	126·3	0·8046	11·9

GEOGRAPHICAL NOTES.

The Royal Geographical Society has determined on a change in the form and alteration in the title of its *Proceedings*, which will materially enhance the value of the monthly publication. The size of each part will be increased to ninety-six pages, and two volumes will be published in the year instead of one as formerly. Internally the arrangement will be slightly altered, and while the strictly geographical character of the publication will be maintained, the notes and record of geographical work from other countries will be made at once more systematic and more popular. A special feature will be the record of the "Geographical Literature" of the month, summarizing all the accessions to the library, both books and memoirs. This will form a subject-index to geographical literature, and serve as a continuous appendix to the exhaustive subject-catalogue of the Society's library which is now being compiled. The editorship of the new series remains in the hands of Mr. J. Scott Keltie, the assistant secretary.

With reference to the note on the death of Lieutenant Schwatka, the Alaskan explorer, published last week, we are glad to observe that an official enquiry negatived the theory of suicide, and showed that the fatal result followed from an overdose of morphia taken medicinally.

The German colonial authorities have recently come to a very important decision as to the official spelling of the place names of their various protectorates in Africa and New Guinea. European names are to retain their ordinary form, but all native names are to be rendered phonetically according to a new set of rules. These rules so closely resemble those put forward by the Royal Geographical Society, and now widely used, that it appears possible by some slight concessions on both sides to make one set serve both for English and German. The letters *c*, *q*, *x*, and *z* are dispensed with as redundant, *c* and *z* being rendered by *ts*, *x* by *ks*, and *q* by *kw*. The gutteral *ch* becomes *kh*, the English *ch* being given as *tsh*, and the sound of the English *j* as *dj*. The German *j* sound will be represented by *y*, and the letter *j* used only for the French sound, which is represented in English as *zh*. The German sound of *w* is rendered as *v*, the letter *w* being kept for the English sound. Unfortunately the letter *s* is kept for its soft German sound, the sharp sound of the English letter being shown by *ʒ*. The use of the English *z* would have overcome this difficulty, and removed the most serious obstacle to a common orthography.

Captain Monteil, whose arrival at Kano on his way to Lake Chad was referred to in May last (vol. xlvi. p. 110), has at last been heard of, and his mission, although involving two years of travel in the Sudan and Sahara, appears to be successfully completed. The facts could not be put more concisely than in Monteil's official telegram to the French Foreign Office, which arrived on November 15:—"October 17. To-day I entered the territory of Fezzan by way of Tejerri coming from Kuka. Having set out from Kano on February 19, I reached Kuka on April 10, where the reception was excellent. I left Kuka on August 15 with a guide, sent by the Sheikh to accompany me to Murzuk . . . . which I expect to reach on or about the 25th, and to stay there just long enough to arrange my departure for Tripoli. Badaire has borne the journey exceedingly well. My men are all with me, except two left at Kuka." This is the most important journey through the Central Sudan and Sahara since the classical explorations of Barth and Rohlfs.

STROMBOLI IN 1891.[1]

Stromboli is one of the most noted but least studied of volcanoes. The regularity of the weak explosions which, succeeding each other at intervals of a few minutes, characterize its normal state, gives rise to the idea that its action is always thus uniform and monotonous, and the occasional paroxysms to which it is subject are apt to be overlooked. In reality the so-called Strombolian phase of volcanic activity differs from the Plinian phase exhibited by Vesuvius and certain other volcanoes merely by the absence of intervals of perfect repose between the violent outbursts which are characteristic of the latter type. It is in this difference that the explanation of the fact is to be found, that from time immemorial no explosion in any way comparable to the great explosions of Vesuvius have occurred at Stromboli; for the ceaseless activity of the latter prevents the accumulation of sufficient force to produce a powerful and destructive effect. But from time to time the throat of the volcano does get more or less choked, and the efforts of the imprisoned vapour to escape result in an eruptive phase of some violence. Such an event took place during the latter months of last year, and the following description of the phenomena is based on the observations of Profs. Ricco and Mercalli, and of Ing. Arcidiacono.

The state of the volcano preceding this outburst had been one of relative calm for two years. In October, 1888, an explosion had opened three new mouths on the upper edge of the Sciara del Fuoco, from one of which lava was emitted. This was the commencement of a period of increased activity, with repeated issue of lava, lasting nine months till June, 1889. From this date to the eruption of last year, and particularly during the six months just preceding, the activity was less than normal. It is to be noticed, however, that there were two short intervals of recrudescence, lasting only a few days, at the end of December, 1890, and January, 1891.

On June 24, 1891, at 12.45 p.m., two strong earthquake shocks were felt over the whole island at an interval of a few seconds. Loud rumblings and a violent explosion followed each. The shocks were not confined to the island of Stromboli, but were felt at Salina, a distance of 40 kilometres. Even the subterranean rumblings were heard at the latter island. The first shock and the first explosion were, as might be expected, more violent than any which succeeded. Windows were broken at the semaphore station, and a great precipice of rock fell into the sea at the Filo del Cane, and other rocks in the same locality were so loosened that they fell on following days. Two powerful columns of ash, like thick smoke, arose from the crater and ascended far above the summit of the island. Great masses of scoria were ejected and fell toward the northern part of the island, burning the grass and fig-trees. A boat passing to the north-east of the island at the time of the first explosion could not see the semaphore signals, owing to the quantity of ash in the atmosphere. Lapilli fell around the eruptive mouths for a radius of a kilometre and a half, and a fine, dark grey ash rained over the whole island. A stream of lava issued from a point on the Sciara del Fuoco near to the most western mouth, and a deep fissure formed its upper rim nearly in the same place as that of November, 1882. For two days the lava continued to flow, and loud explosions were frequent. The rumblings were almost continuous. On the 26th the emission of ash ceased, but moderately vigorous outbursts occurred with the ejection of incandescent scoria till the 27th; but on the 28th and 29th the volcano had resumed its wonted calm. On the 30th, however, a fresh earthquake, accompanied by rumblings and a violent explosion, showed that the volcanic forces were not yet spent. An immense column of vapour and incandescent materials arose from a new breach on the edge of the Sciara, while an abundant current of lava flowed down the slope reaching the sea at its foot. The whole of the powerful explosions o the 30th were repeated at short intervals, but the activity

[1] Sopra il Periodo eruttivo dello Stromboli cominciato il 24 giugno, 1891. Relazione dei Prof. A. Ricco e G. Mercalli col Appendice dell' Ingegnere Arcidiacono ("Annali dell' Ufficio Centrali Meteorologico e Geodinamico" [2] XI. Pt. 3, 1892.)

gradually declined till July 4, when its normal state was reached. The eruptions were again violent, with emission of lava from the 16th to the 23rd of July.

The mouths on the edge of the Sciara, which were contemporaneously active during the above period, were four in number—two at the northern end and two at the western end. One of the former pair was opened by the explosion of June 30, and from it was ejected the greater part of the detrital material of the eruption, so that around it a cone has been built up, truncated by a crater, sub-elliptic in form, of about 60 metres in maximum diameter. The height of this new cone above the old edge of the Sciara is about 50 metres. The other crater is situated on the deep fissure mentioned above, and at night, from the sea the incandescent lava could be seen in free communication with the atmosphere—a circumstance which explains the fact that the explosions from this crater were rare and of feeble intensity. The two western ones were situated one below the other with an interval of about 30 metres. Near the lowest, three large fumaroles gave forth dense columns of steam, while other lesser fumaroles were plentifully scattered about. The majority of the explosions took place from these two mouths. During this same period, lava was emitted three times, (1) on June 24, soon after the first two explosions from the most western part of the Sciara; (2) on June 30, from the crater on the fissure; (3) on July 16, from the central part of the Sciara, between the first two. They all reached the sea, and since the second stream doubled itself round an obstacle about half way in its course, four new points were formed on the shore. The thickness of the lava at these points varied from 4 to 6 metres. Specimens of the lava collected from the most western stream showed that it consisted of an almost homogeneous blackish-brown paste, compact in the interior, but becoming more and more porous and reddish in colour towards the exterior. Some of the larger cavities were internally covered with a shining brown patina. Externally it was covered with a rough crust, reddish-brown in colour, and of scoriaceous aspect. It was sensibly attracted by the magnet, and melted without effervescence to a brownish-green glass. Crystals of plagioclase, augite and olivine were apparent. In section, about two-thirds was rendered opaque and black by very minute microlitic granules of magnetite which were intimately mixed with a transparent glassy base, colourless or inclining to greenish. The remaining third consisted of a great number of colourless transparent microlites of plagioclase. Fluidal structure was only just apparent. In this microlitic paste were scattered crystals of plagioclase, augite, and olivine. The augites were greenish in section and possessed a feeble pleochroism. The olivines were corroded and irregularly fractured.

Analysis gave the following numbers:—

	Stromboli.	Etna. Mean of analyses of 20 modern lavas.
Silica...	50·71	49·45
Alumina	13·99	19·30
Ferric oxide	5·13	11·82
Ferrous oxide	9·10	
Manganous oxide	·42	—
Lime...	10·81	10·21
Magnesia	4·06	3·69
Potash	3·02	1·33
Soda...	2·87	3·58
Loss on ignition	·24	—
Cl and SO_2	(traces)	—
	100·35	99·38

The lava is similar to other lavas of Stromboli, and to show the great similarity between the lavas of Stromboli and Etna, the mean of the numbers of twenty analyses of modern Etna lavas is appended for comparison.

The scoria, lapilli, and ash of the eruption present no special features, but are what might be expected from a lava of the above composition.

Although the volcano had reached a state of comparative calm at the end of July, this did not last for very long. Towards the end of August fresh signs of activity gave warning of an approaching explosion, which took place on August 31. It was preceded by an earthquake a few seconds before, and as a result a vast column of ash rose above the volcano, while scoria and other projectiles were shot out to a considerable distance. Soon after, a fine ash, dark red in colour (instead of black as in June–July), fell over the island, covering the ground in some places to a depth of several centimetres. On the evening of September 1 dense columns of ash were again emitted, and in the afternoon of September 3 the whole crater was enveloped in a thick mantle of steam, in the midst of which could be dimly seen a reddish-grey column of ash rising with extraordinary violence to a great height, when it spread out into a volcanic "pine." A fresh stream of lava was also observed. Eruptions succeeded each other at short intervals, accompanied by continuous rumblings, interrupted now and again by loud explosions, like heavy artillery. As far as could be observed, on the western side of the crater was a single mouth of almost circular form, 10 metres in diameter, which was most active in sending up vast columns of ash and projectiles of all kinds. To the east could be seen one or more little mouths, which tranquilly emitted large volumes of steam, while in the midst a large aperture, 30 metres in diameter, irregular in form and deeply fissured, was in powerful action. The activity, however, gradually quieted down, and towards the end of the year the volcano resumed its normal state.

In conclusion, it is useful to compare this eruptive phase of Stromboli with other contemporaneous seismo-volcanic phenomena of the Italian peninsula. It appears that earthquakes occurred in various districts in the early months of 1891, especially one on June 7 in the Verona district, rather severe, occasioning loss of life. Vesuvius was rather more active than usual during the whole of June, and in correspondence with this the great fumarole of the solfatara at Pozzuoli, increased in temperature. It is particularly interesting to note that Vulcano, the other active volcano of the Lipari Islands, remained in perfect calm during the whole period, emitting only vapour from the fumaroles. As, however, the character of the eruptions and the lithological composition of the material ejected from this volcano differ so greatly from those of Stromboli, it is tolerably certain that there is no free and direct communication between the reservoirs of these two volcanoes. In fact, Stromboli presents a much greater analogy with Etna. The similarity of the lithological composition of the lavas of these two volcanoes has already been referred to, and, further, Prof. Mercalli observes that the last four or five eruptions of Etna have all been immediately preceded or followed by a paroxysm at Stromboli. It is thus possible that there is a real relation between them.

L. W. FULCHER.

A LARGE METEORITE FROM WESTERN AUSTRALIA.

IN the *Mineralogical Magazine and Journal of the Mineralogical Society* of July, 1887 (vol. vii.) Mr. L. Fletcher, M.A., F.R.S., president of the Society, describes four specimens of a new meteoric iron found at Youndegin in Western Australia. They were discovered about three-quarters of a mile to the north-west from the top of Penkarring Rock, in the above district, about seventy miles from York. These fragments were found by Alfred Eaton, a mounted police constable, when on duty in the district of Youndegin, when he brought in one of the four pieces he found on January 5, 1884. Mr. Fletcher states that the late Mr. Edward T. Hardman, F.G.S., the then Government geologist, expressed his belief in the meteoric origin of these iron masses. Later the above-named Alfred Eaton was sent with a native assistant with instructions to bring in the other three pieces, and at the same time an unsuccessful search was made for additional fragments. In the above account it is stated that the four pieces were lying loose on the surface, three of them close together, and the fourth fifteen feet away. They weighed respectively 25¾ lbs., 24 lbs., 17½ lbs., and 6 lbs., the largest and smallest fragments are now in the British Museum collection, and the specimen of 24 lbs. is in the Geological Museum at Freemantle, and the fourth piece, weighing 17½ lbs., was presented to the Melbourne Museum in Victoria.

The new specimen now in my possession was discovered last year, and weighs 382½ lbs., and measures 22¾ inches high, 20½ inches wide, and 13¼ inches in its greatest thickness. In form it is roughly convex on one side and concave on the other, on both sides of which are large depressions or pittings similar to those usually observed on other large masses of meteoric iron. It is somewhat triangular in outline, but with irregular sides. It has one small hole quite through the mass near the top, and numerous deep holes, one near the bottom left-hand corner

having a diameter of about $1\frac{1}{2}$ inches and 4 inches deep; another at the opposite bottom corner 2 inches deep and 2 inches in diameter; also another of 3 inches deep, and several others. On the upper edge especially, and at several other parts near, also on the edges, are fractured surfaces, as if in its fall a mass or masses were broken off, leaving a coarse crystalline structure, and which would indicate that several other large holes having existed before its fall on the earth, probably all or most of the pieces were connected together, and might have fallen in one mass. It would be interesting to know if any of the pieces fitted together at the fractured surfaces as seems to me might be detach a fragment of which the cut face was not $2\frac{1}{2}$ inches square.

Mr. Fletcher also states that on treating a specimen of this Youndegin iron to the action of bromine water, or of dilute nitric acid, the polished section gave no definite figures, but assumed a damascened appearance very like the Tucuman iron and of that of Brazos, being very similar to the latter in the proportion and distribution of the Schreibersite; some specimens of the Arva, the Sarepta, and the recently found Canon Diablo are similar as exhibiting these characters.

One-fifth natural size.

possible. I observe that the two specimens of this iron in the British Museum collection exhibit similar fractures on the edges. Before receiving this specimen I was informed that two masses were found, but have no information at present as to the size and weight of the other.

Mr. Fletcher in his paper minutely describes the size and form of the two British Museum specimens, and that the specific quantity was determined from three small pieces from the larger specimen, and gave 7·86, 7·85, and 7·72. He also states that a portion was cut off the larger piece by means of hack-saws, and was found to be so hard that three weeks were required to

The Youndegin iron was also remarkable in containing the minute cubic and modified cubic crystals, having metallic lustre and of a greyish black colour, and which were determined to be graphitic in character, but of a diamond-like form; but were later found to be still distinct from the diamond, but having somewhat more the features of graphite. Mr. Fletcher therefore decided to give the name of Cliftonite to this substance, as being a new form of a carbon mineral. A most exhaustive description of this new mineral is given in his paper. Similar crystals of this substance are found in one or two other meteoric irons.

The composition of the Youndegin iron was found to be as follows:—

Iron	92·67
Nickel	6·46
Cobalt	0·55
Copper	trace
Magnesium	0·42
Phosphorus	0·24
Sulphur	none
Insoluble cubes	0·04
	100·38

JAMES R. GREGORY.

THE CROSS-STRIPING OF MUSCLE.

PROF. RICHARD EWALD of Strassburg, has just communicated a paper to the fifty-second volume of the *Archiv. f. d. ges. Physiol.*, in which he confirms Prof. Haycraft's views concerning the structure of striped muscle. The latter observer has held for many years that muscle fibrils are varicose threads, and that the cross-striping is but an optical appearance due to this varicosity. The varicosity is often difficult to demonstrate in the ordinary way, and most histologists were not prepared to admit that the stripings are all and entirely due to it. Prof. Haycraft, however, recently brought forward to the Royal Society of London, and to the Berlin International Medical Congress, fresh and striking proof of the strength of his position, by demonstrating films of moist collodion, on which pieces of muscle had been pressed and then withdrawn. As a result of this pressure the collodion films were stamped as with a seal, and the impressions revealed in striking detail every stripe of the original fibre. Prof. Ewald confirms these experiments in the fullest manner, but suggests that the collodion impressions might be produced on the assumption that there are layers of hard and soft material alternating with each other in the course of the fibrils. In this case the hard material would press into the collodion and make a series of furrows, which would appear as a series of stripes when examined with the microscope. Prof. Haycraft had previously demonstrated the varicosity of the fibrils, seen by transmitted light, and had published photographs of his preparations, but Prof. Ewald was still sceptical upon this particular point, and sought to assure himself still more conclusively. With this end in view he examined muscle, which had been rendered quite opaque, by means of reflected light, for under these circumstances the influence of the internal structure would be entirely set on one side, and the surface of the fibrils would alone receive and reflect the illuminating rays. For purposes of illumination Prof. Ewald used the apparatus of W. and H. Seibert, of Wetzler, by means of which vertical rays can be projected upon an opaque object; and he rendered his preparations, both of fresh and of hardened muscle, quite opaque by a method of over-silvering. Under these conditions Prof. Ewald found that the cross-striping is most distinct, and he was able, with his admirable method of illumination, to examine the surface of a muscle just as one may observe the surface of the country at night by means of a search-light from an observatory. With the light perfectly vertical the tops of the ridges of the muscle are bright, and the valleys on either side in half-light. By shifting the light to one side or to another the slopes of the ridges can be thrown alternately into shadow or bright light. Prof. Ewald concludes by admitting that his experiments fully prove that the striping is due to the shape of the fibrils alone, and that the internal structure of the muscle plays no part in its production.

IRIDESCENT COLOURS.[1]

ON taking a general survey of coloured objects, whether natural or artificial, we become aware of the fact that whilst the colours of some remain unchanged as regards tint, whatever their position in relation to the incident light, the tint of others varies with every alteration in their relationship to such light source. We thus see that so far as their colours are concerned all bodies may be arranged in two groups according as their colours change or do not change in tint as their angular relationship to the light varies. Nor is this classification entirely an artificial one, since, as will shortly be seen, though this change in tint with variation in the light source is an essential difference, it is not the only difference, even in the colour manifestations of the two groups, for it is also characteristic of the nature of the colour-producing structure. It is to the above-mentioned varying colours that we apply the term iridescent, from the resemblance they have in the sequence or play of colours to the tints of the rainbow. The unvarying group of colours, having no equivalent term to "iridescence" to express the nature of their colour production, are spoken of as "pigmentary," or absorption colours. In naming examples of objects, natural and artificial, grouped as above in accordance with the nature of their colours, it is difficult to make a selection where all are so varied and characteristic. I have preferred therefore to cite only such instances as I myself possess, and am therefore able to show you. As examples of pigmentary colours, I need only name one or two for the sake of comparison, since the colours of most objects ordinarily met with are pigmentary. Leaves, flowers, dyes, birds, fish, insects, minerals, &c., exhibit these colours, some almost entirely, and all, excepting fish, in far the majority of instances. Of objects displaying iridescent colours we have also examples in the various divisions of the animal, vegetable, and mineral kingdoms. Amongst birds the most striking examples are found amongst the humming birds, sun birds, birds of paradise, &c. Insects, again, furnish numerous examples, more especially amongst tropical species, though not, perhaps proportionally in greater numbers than amongst those belonging to our own more temperate regions. The colours of fish are almost entirely iridescent, since their very whiteness, or silvery sheen, is due to the admixture of the iridescent colours of innumerable minute thin lamellæ, too small to be seen individually with the naked eye, but plainly perceptible under the microscope. In the vegetable kingdom iridescent colours are far more numerous than is ordinarily recognized, since the surfaces of the cell walls produce interference colours which are more or less obscured by the pigmentary colours of leaves and coloured flowers, but may be readily seen in the case of white flowers by the aid of a lens and sunlight. Under these conditions each cell may be seen to sparkle with its own iridescent colour, forming, by admixture of the interference tints of neighbouring cells, the varying shades of white seen in numerous flowers which are devoid of pigmentary colour. Mineral bodies displaying iridescent colours are also numerous; opals, sunstone, fire-marble, felspar, mica films, tarnish on various metallic crystals, certain crystals of chlorate of potash, &c., are examples.

In describing the various natural objects for purposes of identification, or mere description, no account can be considered complete which omits all reference to their colours, and more especially is this the case where the colours constitute such a striking feature, as in the case of iridescent bodies. In innumerable instances, more especially amongst birds and insects, their specific names are taken from some conspicuous colour they possess. It thus becomes evident that a correct description of the colours of bodies is of importance, and where these colours are of the pigmentary, or unchanging kind, this is a matter of no difficulty. How different, however, in the case of objects, the colours of which not only vary with every change of position, but disappear altogether, unless viewed with special relation to the light source. Nor can it be wondered at that descriptions of these objects, even by observers of undoubted repute, vary according to the different angles from which they have been viewed; or are vague and profuse, owing to fruitless attempts to describe their changing tints produced by every movement. The fact is, no words can convey an adequate impression of the gorgeous effects produced by most of such objects, whether birds, insects, or fish, when in motion in brilliant sunshine. Some notion of the difficulties to contend with in describing the colours of humming birds, for example, may be gathered from the remarks of Wallace in his work on "Tropical Nature," when speaking of humming birds:—"In some species they must be looked at from above, in others from below; in some from the front, in others from behind, in order to catch the full glow of the metallic lustre; hence, when the birds are seen in their native haunts, the colours come and go and change with their motion, so as to produce a startling and

[1] By Alex. Hodgkinson, M.B., B.Sc. Reprinted from the fifth volume of the fourth series of "Memoirs and Proceedings of the Manchester Literary and Philosophical Society." Session 1891-92.

beautiful effect." Most observers, in describing the colours of iridescent bodies, do so by attempting to depict the varied effects produced by casually changing the position of the object in relation to the light, omitting to mention the exact *sequence* of the play of colours, or the relation of these colours to the direction of the iridescent light, *i.e.*, whether produced by perpendicular or oblique illumination. Here is a description of the tufted neck humming bird, *Trochilus ornatus*, taken haphazard from a well-known work:—"The throat is of a fine green colour, variable in different lights to a golden hue with a yellow or brown metallic lustre, and below that the whole of the belly is a rich brown, glossed with green, and golden." Such descriptions as the above, which happen to be the first I met with in seeking for an instance, are vague, and fail to give a definite idea of the appearance of the object. But vagueness in the description of these objects is not the only result of the changing character of their colours. As might be expected, where such variation in appearance exists, the descriptions of different authors are almost as variable as the colours. Few attempt descriptions without acknowledging the hopelessness of the task. Thus Jardine, after describing this humming bird, *Chryslampis mosquitus*, remarks:—"It is impossible to convey by words the idea of these tints, and having mentioned those substances to which they approach nearest, imagination must be left to conceive the rest." And I adduce this quotation as fairly expressing the feeling of naturalists in reference to the description of iridescent objects generally. Recognizing the admitted inability of observers to convey by description an idea of the appearance of these iridescent objects, and having myself, for many years, constantly experienced the same difficulty, I have been led to adopt a method for the examination of such objects, which, whilst extremely simple and available in its application, yields unvarying results with different observers, results, moreover, which admit of the simplest description.

Before describing this method, I may say that long experience in the examination of iridescent objects has proved to me that, almost without exception, the colours of natural iridescent objects are due to interference produced by thin plates. In order, therefore, to render clear the principles on which the method I propose is founded, I will briefly refer to certain fundamental facts in connection with colour production by thin plates, and for this purpose will select a thin film of mica, which with light at perpendicular incidence, appears red, iridescent red. If, now, this plate be inclined so that the light falls on it at a more oblique angle, it is, of course, reflected at the same angle, and now appears orange, and if the plate be still further inclined, the reflected light appears yellow, then yellowish green, green, and bluish green, and if the light were not too copiously reflected from the first surface to allow of perceptible interference by further inclination of the plate, all the colours of the spectrum in their proper sequence might be observed. The same results, but much more vividly, may be seen in these crystals of chlorate of potash. Thus, we see that by rendering the incident light more and more oblique, the reflected light changes from a lower to a higher tint, that is, from the red towards the violet end of the spectrum. And this is what occurs in the case of all iridescent bodies, as the incident light becomes more oblique the colour changes to the tint above it in the spectral order, so that, if we know what colour any such object appears when seen at a certain angle, we can infer what colour it will change to on varying the incidence. This beetle (*Sagra purpurea*), for instance, is red at perpendicular incidence, it will, therefore, appear orange yellow and green when examined by successively increased obliquity of light. And the same is true of all other iridescent red objects. If the object at perpendicular incidence be green, as in the case of this beetle (*Bupristis*), it will become blue and then violet as the incidence is increased. We thus see that an iridescent object varies in colour, simply because it is examined by light incident, and therefore reflected, at different angles. Thus, different observers see the same iridescent object of a different colour, when they view it illuminated by light at a different angle of incidence. If, however, the object is seen by all at the same angle of the incident light it will present the same colour, and this is, in fact, what the method I propose ensures, *i.e.*, that iridescent objects shall always be seen by light at one and the same angle of incidence. The angle I select is one of 90, so that the incidence and reflection are normal or perpendicular to the reflecting surface. By selecting this angle all trouble of measuring angles is avoided, since we know that the incidence is perpendicular when it coincides with reflection. Now, the reflected light may be made to coincide with the incident light by reflecting it on to the object by means of a mirror, and so adjusting the object that the light reflected from it passes to the eye through a perforation in the mirror. When examined in this way iridescent objects are marvellously altered in appearance, their changing colours are replaced by one fixed tint, visible only in one position, a fact which serves at once to distinguish them from bodies coloured by absorption, which remain coloured whatever the relation to the incident light. Such methods of examining bodies scarcely takes more time than by the eye alone. The mirror may be attached to a spectacle frame so as to leave both hands free, such as the one I show, or may be a simple hand mirror. For objects too small to be seen by the unaided eye, I have so arranged the microscope that light is made to pass down the tube of the instrument, through the object glass on to the objects, and by a special arrangement, so adjusted the position of the object that the light is reflected back again through the instrument to the eye. The method is thus available for macroscopic as well as microscopic objects.

To illustrate the practical value of this plan of examination, I have here a few objects exhibiting iridescent colours, which, by trial, will be found to give the following results:—

The crest of this humming bird, *Chrysolampis mosquitus*, which, to the unaided eye, appears resplendent with all shades of red, orange, yellow, or green, according to the angle of the incident light, appears, when examined by the mirror, of one unvarying red tint, disappearing when the object is moved but absolutely unchanging in tint. Such an object, therefore, I should describe as "iridescent red"; all else regarding its colour may be inferred. Again, the breast, or gorget, of the same bird reflects all shades of orange, yellow, or green to the eye alone; with the mirror it is seen of a deep orange, which, as before, is unchanged in tints by any variation in position. Such an object I would describe as "iridescent orange." The gorget of another humming bird, *Calliphlox amethystina*, to the eye alone appears crimson, orange, yellow, or green: with the mirror it is iridescent crimson only, spectroscopically a red of the 2nd order. Amongst insects, instances of iridescent species are numberless, the results of examination are just the same as in other iridescent bodies. This butterfly, *Morpho*, to the eye alone appears either greenish-blue, blue, or violet, as its inclination to the light varies; examined with the mirror it appears green, and should be described as iridescent green, or iridescent bluish-green. This beetle, *Poropleura bacca*, appears any shade of red, yellow, or green to the eye alone; with the mirror only iridescent red. In this extraordinary beetle, *Chrysochroa fulminans*, we have all the colours of the spectrum in their natural sequence, beginning with red at the tip of the wing case, and ending with violet higher up the elytron. These colours vary in an indescribable manner when attentively examined at different angles of incident light with the eye alone; with the mirror the wing cases are seen to be coloured successively from base to tip iridescent green, yellow, orange, and red, and these tints remain unaltered by change of position of the object. This piece of *Haliotis* shell exhibits indescribable changes of colour with every movement, but the difficulty of description, though by no means removed, is immeasurably lessened by the use of the mirror. And the same with this specimen of iridescent iron ore, its colours, which vary to the unaided eye, remain unchanged when examined by the mirror. To simplify the description of iridescent objects, therefore, I would advocate the above method, and would describe the result of such examination by recording the colour observed by aid of the mirror, and prefixing the term "iridescent" to express the changing properties of the colour. Bearing in mind the unvarying nature of these changes, a far clearer idea may be formed of the appearance of these objects than from any attempted description of what is admittedly indescribable. Time and space are also economized by the omission of lengthy descriptions. The accuracy, and, therefore, the value of any description of colour, is always enhanced by mapping its spectrum; more especially is this true in the case of iridescent colours. This is easily done, and by applying such map to a spectral chart, the order of the colour, and therefore its tint, is apparent. In examining many objects, chiefly birds or insects, by means of the mirror as above described, apparent exceptions are repeatedly met with to the fact stated above, that the colour

is invariable in tint and disappears by inclination of the body. Such instances are no real exceptions, but are due to the reflecting plates being curved, or having pigmentary matter beneath them, or an opalescent medium above them. In this way some of the most extraordinary and beautiful colour effects it seems possible to conceive are produced.

In examining objects with the perforated mirror a single light is necessary. The sun is of course the best, and the electric light probably almost as good. I frequently employ the lime-light, but a good paraffin lamp may be used as a substitute. Ordinary gas is unsuitable. The light should be placed in front of the observer, its direct rays being prevented from falling on the objects by means of a book or partition of some kind resting on the table, and of such a height that the light can be seen above it. On placing the mirror to the eye the light may be reflected from the mirror on to the object, and the latter manipulated so as to reflect the ray back through the perforation in the mirror to the eye. The incidence is thus known to be normal, and the colour observed is the one to be recorded.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The following letter has been addressed by the University of Cambridge to that of Padua, which is about to celebrate the tercentenary of Galileo's professorship :—

Universitas Cantabrigiensis Universitati Patavinae S.P.D.

Litteras vestras, viri doctissimi, GALILAEI GALILAEI Professoris vestri celeberrimi in laudem conscriptas vixdum nuper perlegeramus, cum statim in mentes nostras rediit non una Italiae regio viri tanti cum memoria in perpetuum consociata. Etenim nostro quoque e numero nonnulli urbem eius natalem plus quam semel invisimus, ubi Pisano in templo lucernam pensilem temporis intervallis aequis ultro citroque moveri adhuc iuvenis animadvertit; etiam Vallombrosae nemora pererravimus, ubi antea scholarum in umbra litteris antiquis animum puerilem imbuerat; ipsa in Roma ecclesiam illam Florentinam intravimus, ubi doctrinae suae de telluris motu veritatem fato iniquo abiurare est coactus; Florentiae denique clivos suburbanos praeterivimus, ubi provecta aetate caeli nocturni sidera solus contemplabatur, ubi extrema in senectute diei lumine orbatus cum MILTONO nostro collocutus est, ubi eodem demum in anno mortalitatem explevit, quo NEWTONUS noster lucem diei primum suspexit.

Hodie vero ante omnia non sine singulari voluptate sedem quandam doctrinae insignem, intra colles Euganeos urbemque olim maris dominam positam recordamur, ubi trecentos abhinc annos saeculi sui ARCHIMEDES discipulorum ex omni Europae parte confluentium numero ingenti erudiendo vitam suam maturam maxima cum laude dedicavit; ubi, ut LIVII vestri verbis paulum mutatis utamur, ultra colles camposque et flumen et assuetam oculis vestris regionem late prospiciens, caelo in eodem, sub quo vosmet ipsi nati estis et educati, instrumento novo adhibito inter rerum naturae miracula primus omnium Lunae faciem accuratius exploravit, Iovis satellites quattuor primus detexit, Saturni speciem tergeminam primus observavit, ultraque mundi orbem ingentem a Saturno lustratum fore suspicatus est ut etiam alii planetae aliquando invenirentur.

Ergo vatis tam veracis, auguris tam providi in honorem, nos certe, qui Professorum nostrorum in ordine planetae etiam Saturno magis remoti ex inventoribus alterum non sine superbia nuper numerabamus, hodie alterum ex Astronomiae Professoribus nostris, Georgium DARWIN, nominis magni heredem, nostrum omnium legatum, quasi Nuntium nostrum Sidereum, ad vosmet ipsos libenter mittimus. Vobis autem omnibus idcirco gratulamur quod tum Italiae totius, tum vestrae praesertim tutelae tradita est viri tanti gloria, qui divino quodam ingenio praeditus rerum naturae in provincia non una ultra terminos prius notos scientiae humanae imperium propagavit quique caeli altitudines immensas perscrutatus mundi spatia ampliora gentibus patefecit. Valete.

Datum Cantabrigiae
a. d. viii *Kal. Decembres*
A. S. MDCCCXCII.

Mr. F. Darwin has been appointed Deputy Professor of Botany for the current academical year, Prof. Babington being unable to lecture on account of the state of his health.

SCIENTIFIC SERIALS.

American Journal of Science, November.—Unity of the glacial epoch, by G. Frederick Wright. An examination of the evidence in favour of two successive glacial epochs separated by an inter-glacial epoch, during which the glaciated area was as free from ice as it is at the present time. This evidence is shown to be inconclusive, at least as far as American observations go.—A photographic method of mapping the magnetic field, by Charles B. Thwing. Iron filings are strewn upon the film side of a dry plate laid horizontally in a magnetic field, and the plate is exposed to light from above. The filings are then brushed off, and the plate developed. From the negatives excellent lantern slides may be obtained.—Contributions to mineralogy, No. 54, by F. A. Genth, with crystallographic notes by S. L. Penfield. Description and analysis of aguilarite, metacinnabarrite, döllingite, rutile, danalite, yttrium-calcium fluoride, cyrtolite, lepidolite, and fuchsite.—The effects of self-induction and distributed static capacity in a conductor, by Frederick Bedell, Ph.D., and Albert C. Crehore, Ph.D.—The quantitative determination of rubidium by the spectroscope, by F. A. Gooch and J. I. Phinney. The method is that of comparing photometrically the intensity of a certain line in the spectrum of the metal under investigation with the intensity of that given by a standard solution containing a known amount of the metal. A definite amount of the salt solution—usually the chloride—is taken up by a hollow coil of platinum wire, which may be made to take up constant quantities of liquid by taking care to plunge the coil while hot into the liquid, and removing it with its axis inclined obliquely to the surface. The coils were made of platinum wire 0·32 mm. in diameter, wound in about thirty turns to a spiral 1 cm. long by 2 mm. across, and twisted together at the ends to form a long handle. Each coil held 0·02 gr. of water. With such a coil, the blue rubidium lines were produced in a Muencke burner from 0·0002 mgr. of the chloride. Some test experiments showed that in the case of pure solutions of rubidium chloride the percentage could be found spectroscopically up to 1 part in 30,000 with an error as low as 1·25 per cent. In presence of potassium or sodium, however, the error may be as great as 20 per cent.—Notes on the meteorite of Farmington, Washington County, Kansas, by H. L. Preston.—A note on the cretaceous of North-western Montana, by H. Wood.—A deep artesian boring at Galveston, Texas, by R. T. Hill.—Notice of a new Oriskany fauna in Columbia County, New York, by C. E. Beecher, with an annotated list of fossils, by J. M Clarke.—Description of the Mount Joy meteorite, by E. E. Howell.—Influence of the concentration of the ions on the intensity of colour of solutions of salts in water, by C. E. Linebarger.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 17.—"Stability and Instability of Viscous Liquids," by A. B. Basset, F.R.S. (Abstract.) —The principal object of this paper is to endeavour to obtain a theoretical explanation of the instability of viscous liquids, which was experimentally studied by Professor Osborne Reynolds.[1]

The experiment, which perhaps most strikingly illustrates this branch of hydrodynamics, consisted in causing water to flow from a cistern through a long circular tube, and by means of suitable appliances a fine stream of coloured liquid was made to flow down the centre of the tube along with the water. When the velocity was sufficiently small, the coloured stream showed no tendency to mix with the water; but when the velocity was increased, it was found that as soon as it had attained a certain critical value, the coloured stream broke off at a certain point of the tube and began to mix with the water, thus showing that the motion was unstable. It was also found that as the velocity was still further increased the point at which instability commenced gradually moved up the tube towards the end at which the water was flowing in.

Professor Reynolds concluded that the critical velocity W was determined by the equation

$$W a \rho / \mu < n,$$

where a is the radius of the tube, ρ the density, and μ the viscosity of the liquid, and n a number; but the results of this

[1] *Phil. Trans.* 1883, p. 935.

paper show that this formula is incomplete, inasmuch as it does not take any account of the friction of the liquid against the sides of the tube.

In the first place, if the surface friction is supposed to be zero, so that perfect slipping takes place, the motion is stable for all velocities. If ϵ^{kt} be the time factor of a disturbance of wave-length λ, the value of k is

$$k = -\frac{2\iota\pi W}{\lambda} - \frac{\mu}{\rho a^2}\left(\frac{4\pi^2 a^2}{\lambda^2} + n^2\right) \quad \ldots\ldots (1),$$

where n is a root of the equation $J_1(n) = 0$.

Experiment shows that when the velocity is greater than about six inches per second, the frictional tangential stress of water in contact with a fixed or moving solid is approximately proportional to the square of the relative velocity. This introduces a constant β, which may be called the coefficient of sliding friction, whose dimensions are $[ML^{-3}]$, and are therefore the same as those of a density. This constant may have any positive real value; $\beta = 0$ corresponding to perfect slipping or zero tangential stress, whilst $\beta = \infty$ corresponds to no slipping, which requires that the velocity of the liquid should be the same as that of the surface with which it is in contact. Owing to the intractable nature of the general equations of motion of a viscous liquid, I have been unable to obtain a complete solution, except on the hypothesis that β is an exceedingly small quantity. This supposition, I fear, does not represent very accurately the actual state of fluids in contact with solid bodies; but at the same time the solution clearly shows that the instability observed by Prof. Reynolds does not depend upon viscosity alone, but is due to the action of the boundary upon a *viscous* liquid.

To a first approximation, the real part of k is proportional to

$$\frac{Wa\beta}{\mu} - \frac{(n^2 + m^2 a^2)^2}{4n^2} \quad \ldots\ldots\ldots (2),$$

where $2\pi/m$ is the wave-length of the disturbance, and n is a root of the equation $(J_1 n) = 0$. Since the second term is a number, this shows that the motion will be stable, provided

$$Wa\beta/\mu < \text{a number.}$$

The experiments of Prof. Reynolds conclusively show that the critical velocity at which instability commences is proportional to μ/a; and the fact that the theoretical condition of stability turns out to be that Wa/μ, multiplied by a quantity of the same dimensions as a density, should be less than a certain number, appears to be in substantial agreement with his experimental results.

The results of the investigation may be summed up as follows:—

(i.) *The tendency to instability increases as the velocity of the liquid, the radius of the tube, and the coefficient of sliding friction increase; but diminishes as the viscosity increases.*

(ii.) *The tendency to instability increases as the wave-length $(2\pi/m)$ of the disturbance increases.*

The remainder of the paper is occupied with the discussion of a variety of problems relating to jets and wave-motion.

I find that when a cylindrical jet is moving through the atmosphere, the tendency of the viscosity of the jet is always in the direction of stability. The velocity of the jet does not affect the stability unless the influence of the surrounding air is taken into account; if, however, this is done, it will be found that it gives rise to a term proportional to the product of the density of the air and the square of the velocity of the jet, whose tendency is to render the motion unstable. The tendency of surface-tension (as has been previously shown by Lord Rayleigh) is in the direction of stability or instability according as the wave-length of the disturbance is less or greater than the circumference of the jet.

If in addition, the jet is supposed to be electrified, the condition of stability contains a term proportional to the square of the charge multiplied by a certain number, n. When the ratio of the circumference of the jet to the wave-length is less than 0·6, n is positive, and the electrical term tends to produce stability; but when this ratio is greater than 0·6, n is negative, and the electrical term tends to produce instability. It must, however, be recollected that when the above ratio is greater than unity the tendency of surface tension is to produce stability; but if the influencing body is capable of inducing a sufficiently large charge, the electrical term (when $2\pi a > \lambda$) will neutralize the effect of surface tension and viscosity, and the motion will be unstable.

The well-known calming effect of "pouring oil on troubled waters" has passed into a proverb. The mathematical investigation of this phenomenon is as follows:—The oil spreads over the water so as to form a very thin film; we may therefore suppose that the thickness l of the oil is so small compared with the wave-length hat powers of l higher than the first may be neglected. Also, since the viscosity of olive oil in C.G.S. units is about[1] 3·25, whilst that of water is about 0·014, the former may be treated as a highly viscous liquid, and the latter as a frictionless one.

The result is as follows:—

Let ρ_1, ρ be the densities of the water and oil, T_1 the surface tension between oil and water, T the surface tension between oil and air, μ the viscosity of the oil, and ϵ^{kt} the time factor, then, to a first approximation,

$$k = -\frac{\{g(\rho_1 - \rho) + T_1 m^2\}(g\rho - Tm^2)l}{4\mu\{g\rho_1 - (T - T_1)m^2\}}$$

For olive oil, $T_1 = 20·56$, $T = 36·9$, so that $T > T_1$; and I find that the motion will be stable unless the wave-length of the disturbance lies between about 9/11 and 6/5 of a centimetre. This result satisfactorily explains the effect of oil in calming stormy water.

OXFORD.

University Junior Scientific Club, October 26.—Mr. E. L. Collis, in the absence of Mr. Bourne, gave an exhibit of *Codium tomentosum*.—Mr. F. C. Britten gave an exhibit of the nest of a trapdoor spider.—Mr. Hill read an interesting paper on the determination of sex, which was followed by a long discussion.—Mr. Fisher exhibited some specimens of crystallized anhydrous oxalic acid, and described their methods of preparation.

CAMBRIDGE.

Philosophical Society, October 31.—Prof. G. H. Darwin, President, in the chair.—The following officers were elected for the ensuing session:—President: Prof. Hughes. Vice-Presidents: Dr. Cayley, Prof. G. H. Darwin, Dr. Hill. Treasurer: Mr. R. T. Glazebrook. Secretaries: Dr. Hobson, Mr. J. Larmor, Mr. Bateson. New Members of Council: Prof. Thomson, Mr. F. Darwin, Dr. Shore, Mr. Ruhemann.—The retiring President addressed the Society.—The following communications were made:—Note on the determination of low temperatures by platinum-thermometers, by Mr. E. H. Griffiths and Mr. G. M. Clark. The authors, following up the suggestion of Profs. Dewar and Fleming, that the resistance of certain pure metals vanishes at absolute zero, have assumed the possibility of extrapolating the platinum thermometer formulæ, and have thus found the temperature at which $R = 0$. From the previously-published constants of seven different thermometers—including Callendar's original wire—the mean value deduced by them is $-273°·86$, which is in remarkable agreement with Joule and Thomson's thermodynamical value $-273°·7$. They further suggest that the simple method of determining the resistance in ice and steam and assuming $R = 0$ when $t = -273°·7$ is sufficient to graduate a thermometer constructed of fairly pure wire, as they show that the errors so introduced will only amount to a fraction of a degree over the range $-273°$ to $+150°$.—Carnot's principle applied to animal and vegetable life, by Mr. J. Parker. The author discusses the question whether the conditions of the growth of plants are limited by the law of entropy. The assumption is made that Carnot's principle takes account only of the exchange of heat, and the temperature of the material system at which the exchange takes places; that the differential effect of solar radiation of different kinds consists in variation of the activity but not of the mechanical type of the growth. The increase of available energy due to the building up of inorganic materials into a plant can then only be explained, in conformity with the second law of thermodynamics, by the aid of differences of temperature during growth: the author gives calculations to prove that the difference between day and night is amply sufficient for this purpose.—Note on the geometrical interpretation of the quaternion analysis, by Mr. J. Brill.

[1] Osborne Reynolds, *Phil. Trans.* 1886, p. 17.

Paris.

Academy of Sciences, November 14.—M. d'Abbadie in the chair.—Heat of combustion of camphor, by M. Berthelot.—Remarks on a note by M. A. Colson on the rotating power of the diamine salts, by M. C. Friedel.—Researches on the chemical constitution of the peptones, by M. P. Schützenberger.—Influence of the distribution of manures in the soil upon their utilization, by M. H. Schlœsing.—On the laws of dilatation of gases under constant pressure, by M. E. H. Amagat. Tables are given of coefficients of expansion of carbon dioxide under pressures ranging from 50 to 1000 atm., and temperatures up to 258°; and for oxygen, hydrogen, nitrogen and air, under pressures up to 3000 atm. For CO_2 the coefficient has a maximum at a certain pressure for each range of temperature. This maximum corresponds to a higher pressure as the temperature rises. For the other gases the coefficient decreases regularly as the pressure increases. As regards temperature, the coefficient of expansion of CO_2 for each pressure reaches a maximum at a certain temperature and then decreases. This temperature is the higher, the greater the pressure. The more permanent gases behave as if they had already passed their maximum.—Study of the pathogenic power of fermented beet-root pulp, by M. Arloing.—Observations of the new comet Holmes (*f* 1892), made at the Paris Observatory (west equatorial), by M. G. Bigourdan (see Astronomical Column).—Transformation of the great telescope of the Paris Observatory for the study of radial velocities of the stars, by M. H. Deslandres (see Astronomical Column).—Summary of solar observations made at the Royal Observatory of the Roman College during the third quarter of 1892, by M. P. Tacchini.—On the inversion of Abelian integrals, by M. E. Goursat.—On the summation of a certain class of series, by M. d'Ocagne.—On the equations of dynamics, by M. R. Liouville.—Experimental researches on the deformations of metallic bridges, by M. Rabut.—Conditions of equilibrium and of formation of liquid microglobules, by M. C. Maltézos. The following experimental results were arrived at: When a liquid spreads over the free surface of a denser liquid, microglobules are produced on inverting the position of the two liquids. If a liquid rests in drops on the surface of a denser liquid, then in the inverse position the denser will spread over the less dense liquid.—Demonstration of the existence of interference of electric waves in a closed circuit, by means of the telephone, by M. R. Colson. A Rhumkorff coil was kept vibrating at 130 per second by a thermopile. To one of its terminals was attached a copper wire ending in a hook, to which a linen thread soaked in calcium chloride was attached by one end, the other hanging free. One of the terminals of a telephone was placed in contact with the thread, the other terminal being isolated. Under these conditions, the sound in the telephone was completely extinguished at a certain distance from the copper. When both the ends of the thread (which was 3 m. long) were connected up by fine copper wires, two points of extinction were reached, one from each end. On shortening the thread these points approached each other and formed a zone of extinction between them. This zone of extinction spread over the entire copper wires as the thread was shortened to zero. The neutral zone is due to interference of two waves of the same period and of equal potential meeting in opposite directions.—On the co-existence of dielectric power and electrolytic conductivity, by M. E. Cohn.—Observations on the preceding communication, by M. Bouty.—Magnetic properties of bodies at different temperatures, by M. P. Curie. These were measured by bringing samples of the bodies between the ends of two electromagnets inclined to one another, and measuring the forces experienced by means of a torsion balance. The bodies were heated in a porcelain crucible, the heat being supplied by platinum wires carrying a current, and measured by a Chatelier thermocouple.—On the propagation of vibrations through absorptive isotropic media, by M. Marcel Brillouin.—On a new relation between variations of luminous intensity and the numerical order of the sensations, determined by means of a luminous paint, by M. Charles Henry.—Essay of a general method of chemical synthesis: experiments, by M. Raoul Pictet.—On the fusion of carbonate of lime, by M. H. Le Chatelier.—On the molecular weights of sodammonium and potassammonium, by M. A. Joannis.—On some crystallized sodium titanates, by M. H. Cormimbœuf.—On a propylamidophenol derived from camphor, by M. P. Cazeneuve.—On the colouring matter of the pollen, by MM. G. Bertrand and G. Poirault.—On the manufacture of melanite garnet and sphene, by M. L. Michel.—On the rotating power of solutions, by M. Wyrouboff.—Researches on the mode of elimination of carbonic oxide, by M. L. de Saint-Martin.—Vital fermentations and chemical fermentations, MM. Maurice Arthus and Adolphe Huber.—Remarks on the preceding communication, by M. A. Gautier.—Influence of the transfusion of blood from dogs vaccinated against tuberculosis upon tuberculous infection, by MM. J. Héricourt and Ch. Richet.—On a new species of chromogenic bacteria, the *Spirillum luteum*, by M. Henri Jumelle.—On two parasitic myzostomes of the *Antedon phalangium* (Müller), by M. Henri Prouho.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—Manners and Monuments of Prehistoric Peoples: Marquis de Nardaillac, translated by N. Bell (Putnam).—An Elementary Text-book of Hygiene: H. R. Wakefield (Blackie).—More about Wild Nature: Mrs. Brightwen (Unwin).—The Pharmacy and Poison Laws of the United Kingdom (office of the *Chemist and Druggist*).—Lessons in Elementary Algebra, 1st series: L. J. Pope (Bell).—The Visible Universe: J. E. Gore (Lockwood).—Man and the Glacial Period: Dr. G. F. Wright (K. Paul).—Sinai from the Fourth Egyptian Dynasty to the Present Day: late H. S. Palmer, new edition, revised by Prof. Sayce (S.P.C.K.).—Time and Tide, 2nd edition: Sir R. S. Ball (S.P.C.K.).—Les Races et les Langues: Prof. A. Lefèvre (Paris, Alcan).—A Contribution to our Knowledge of Seedlings, 2 vols.: Sir John Lubbock (K. Paul).—Australasian Newspaper Directory, 3rd edition, 1892 (Gordon and Gotch).—Sultan to Sultan: M. French-Sheldon (Saxon).

Pamphlets.—Recherches d'Optique Physiologique et Physique, Part 2: C. Royer (Bruxelles, Monnom).—Fauna Americana: D. T. de Aranzadi (Madrid).

Serial.—L'Anthropologie, tome iii. No. 4 (Paris, Masson.

CONTENTS.

THURSDAY, DECEMBER 1, 1892.

CHEMICAL LECTURE EXPERIMENTS.

Chemical Lecture Experiments. By G. S. Newth. (Longmans, 1892.)

"ON revient toujours," &c. and the very description of a good lecture experiment to one who had for thirty years always enjoyed performing an old one, and was overjoyed in bringing out a new one, is something akin to that of the old war-horse when he scents the battle from afar. And both Mr. Newth's experiments and his descriptions are good; so I think that not only the novices of the profession but the old hands will read this book—the first with profit with a view to what they will do, and the second with pleasure in recollecting what they have done. I was dining some years ago with the great Dumas (I don't mean either of the novelists), and after dinner we sat together on the sofa smoking our cigars, when he said to me, "I have been in many positions—professor, minister of state, and investigator—and I have seen the world from many points of view. If I had to live my life again I would not leave my laboratory. The greatest pleasure in my life has been original work; the second greatest that of teaching a class who appreciated what I was telling them." We all know that Dumas was a master in the art of experimental teaching, and those who have practised this art, even at a great distance from the master, will agree with him that the pleasure of giving a well-illustrated experimental lecture on chemistry is not a small one, and even that a man may go on for thirty years and yet not be altogether tired of the job. The reason for this is not far to seek. Our science in its daily progress constantly opens up new paths which yield matter suitable for lecture experiment, and this gives a zest to the discourse unattainable by the teachers of most other subjects. Mr. Newth has collected an ample store, and he has described them clearly. For the collection he has had favourable opportunity; to begin with he was a distinguished student at Owens, and there he may have picked up a few wrinkles; then he has for many years been Lecture Demonstrator to Frankland and Thorpe, and from them the wrinkles he has picked up have certainly been many. But although doubtless some are of his own finding out, I think it would have been well if he had added after the description of each experiment the name of the authority with whom it originated. Thus some have been described by the chemists I have named, others owe their existence to Hofmann, Bunsen, and others. These additions are not only due to the authors, but would add to the interest of the book. Mr. Newth should see to this in the next edition. The old booksellers tell us that Faraday's "Manipulations" is a work which no lecturer should be without, and as everything which that prince of experimenters wrote or did is worthy of attention, they speak truly, and yet no modern chemists can be bound by Faraday's experience of sixty years ago. Things are not as they were; and the methods of work and the illustrations of chemical phenomena which he details belong to a bygone age. And so Mr. Newth comes forward to give the lecturer of to-day a helping hand. The first thing that strikes one on looking through his pages, is how simple are the experiments—so far as illustrating the chemistry of the non-metals goes, and he goes no further—needed to illustrate a course of lectures. We do not require the expensive and delicate instruments of the physicist. With glass and india-rubber, as Liebig said, we chemists perform all our mysteries. Only in a few cases, as, for instance, when we want to hand round wine-glasses filled with liquefied oxygen or air, or when we desire to show our students free fluorine and such like things, does the apparatus become expensive or the experiments troublesome. All the ordinary and many of the extraordinary experiments detailed in the book may be carried out with little cost and without great trouble; indeed most of them may be made by the veriest tyro provided he stick to the letter of the description and does not attempt to vary the proceedings, as one I knew did, who thought that as sulphuric acid is a more powerful desiccating agent than lime, he would dry his ammonia by the former substance instead of by the latter material. No account of any experiment, the author tells us, has been introduced upon the authority solely of any verbal or printed description, but every experiment has been the subject of his personal investigation and the illustrations are taken from his original drawings, so that we may be sure that every experiment will "go" if properly managed and fairly dealt with. Many of the experiments are, of course, old stagers, but none the less useful, whilst others are new to me and probably to most people. To mention many either old or new this is not the place, but one of them, which has struck me as interesting is an easy method of showing the freezing of water by its own evaporation first with a common air-pump, and second with no air-pump at all. I always used a Carre's machine, by which a quart of water could be frozen, but Mr. Newth gives an excellent description of how a beautiful icicle twenty to thirty centimetres long can be obtained both with and without an air-pump. The secret of how to do this can best be learnt by reading pages 57 to 59 of the book. "How to float soap bubbles upon carbon dioxide" has often proved a difficult question to answer experimentally, because if you managed, after a score of trials, to free your bubble from the pipe on which you blew it, the bubble usually bursts the moment it touches your heavy gas. Mr. Newth lets us into the secret. You must remove every trace of hydrochloric acid, which is carried over with the gas, by washing, the presence of this acid being fatal to the life of a soap bubble. Under chlorine (p. 88) a description is given of the mode of sealing up bulbs filled with chlorine and hydrogen. This was first done in the early sixties by my old helper and friend Mr. Joseph Heywood, of Owens, to whom both students and lecturers owe many an ingenious and striking experimental illustration. As Mr. Newth remarks, there are many obvious reasons why the old plan of filling a soda-water bottle with a mixture of equal volumes of the gases and then throwing it out of the lecture-room window into the street, if the sun happened to shine, is "unsuitable for a lecture experiment," and Heywood's bulbs answer the purpose better in all respects. The author does not tell us—as he ought to have done—

that Victor Meyer now seals up bulbs of oxygen and hydrogen (electrolytic gas) in a similar way, and that these, like their confrères of Cl and H, can be kept not only in the dark for any time, but, unlike these, also in the light without undergoing any change. The fact that many gases when perfectly dry do not combine is illustrated by the case of chlorine and metals—brass and sodium, pp. 84 and 85—as well as of carbon monoxide and oxygen, for these gases will not explode if dry, p. 189. A more striking way of illustrating this latter case than that with the eudiometer is not mentioned. I will add it. Dry a current of carbonic oxide over glass balls moistened with strong sulphuric acid; light the stream of gas issuing from a horizontal tube; then plunge over the blue flame a cylinder full of air which has been previously dried by shaking it up with a little strong sulphuric acid. The flame instantly goes out. Another case of the kind observed by Arnold lends itself to a lecture experiment. He found that powdered iron will not burn in pure dry oxygen, and in order to be able to estimate hydrogen in iron it was found necessary to insert a small tube containing a drop of water, through which the oxygen passed before coming into contact with the iron, this tube being of course weighed both before and after the experiment. This may well be included in the next edition, which I hope will soon be called for. Another capital experiment to show that iron can be carbonized by contact with a diamond was recently described to me by Mr. Gilbert Fowler, of Owens. A loop of pure thin iron wire is placed in a vertical glass tube surrounded by an atmosphere of hydrogen. Below the loop is a splinter diamond (or some diamond dust) placed on the top of a glass rod working through the lower end of the tube. After heating the wire by a current to the highest possible temperature without fusion, bring the diamond carefully into contact with the heated iron. The metal at once fuses. But of good experiments "there is no end" (Mr. Newth describes 620 for the non-metals alone) whilst of a review of a book in NATURE there must be a speedy end, and I will end by advising all those who like to see and to show good experiments to get Mr. Newth's book.

H. E. ROSCOE.

A MANUAL OF PHOTOGRAPHY.

A Manual of Photography. By A. Brothers, F.R.A.S. (London: Charles Griffin and Co., 1892.)

MR. BROTHERS has in this well-illustrated book brought together a great amount of information relative to the history, processes, apparatus, materials, &c., which will be welcomed by all who are interested, even if only in a general way, in the fascinating art of photography. The work covers about 360 pages, is divided into five parts and is accompanied by a full index.

In the short historical sketch which is introduced as the opening chapter, the author by means of quotations and otherwise gain much information which is not readily accessible, and many facts that are not inserted in our treatises, and which consequently are not generally known. At the present day, when so many possess a camera of some sort or other, it is very curious to carry ourselves back to the time of Daguerre and to picture to ourselves the idea which he put forward when he wrote in his pamphlet, "Those persons are deceived who suppose that during a journey they may avail themselves of brief intervals while the carriage slowly mounts a hill to take views of a country." Whether this is or is not the case now we will not stop to discuss, but we may mention that many other very interesting extracts are made from the same source.

The next three chapters deal with the chemistry, optics, and light as applied to photography. In these there seems to be nothing that calls for special attention, unless it be to state that the author has written them in a charming manner, as for instance the short summary under the heading "Magnesium Light," which one reads with quite renewed interest.

Coming now to Part II., Processes, we find the most important section of the whole book. As Mr. Brothers rightly observes, the old processes previous to the introduction of the gelatine bromide methods have been put completely in the shade, not because they have been surpassed by better and more trustworthy ones, but simply because they require a little more care in manipulation and consequently the consumption of more time. In order to remedy this to some extent he has given great prominence to them, dedevoting nearly 140 pages to them, including working details of the more important later processes. For the sake of facility of reference they are arranged in alphabetical order, and in many cases they are accompanied by illustrations which show the actual results that can be obtained by the uses of the methods under consideration. To cite them in anything like detail would carry us too far away, but we may mention one or two briefly. The (wet) collodion process is of course here fully described: the author lays special stress on the advantage of this process, for there is no doubt that where dry plates are now used far better results could be obtained by employing this old wet process. The photo-mechanical process, collotype, receives also a rather lengthy description, but its utility and the excellence of the results obtained necessarily give it some prominence. A specimen illustration of the last mentioned is inserted, as well as one of a recent application of this method for printing in colour. Printing on wood, photo-lithography, platinotype, &c., together with photogravine Woodbury type and a host of others, are all described, some briefly, others of greater importance somewhat more in full.

Parts III. and IV. deal with the apparatus and materials used in the production of a finished picture. In the former the author describes the particular characteristics of many of the various kinds of cameras and accessories, while in the latter are explained the chief uses and actions of the chemicals employed.

Part V., the last, contains short notices of the applications to which photography has given rise. Astronomical Photography is referred to at some length, and we may mention that we have an excellent reproduction of one of Mr. Rutherfurd's beautiful lunar photographs taken at first quarter. The practical

hints in the concluding chapter should be found very serviceable.

Mr. Brothers has produced a very serviceable and useful addition to our photographic literature; as a handbook for students it perhaps is somewhat too bulky, but nevertheless it will be very much used by them. Every photographer who wishes to know something about the art with which he is working, and who does not wish to limit himself to the mere cut-and-dried manipulations, should at any rate make himself acquainted with the volume. W. J. L.

MATRICULATION CHEMISTRY.

Matriculation Chemistry. By Temple Orme. (London: Lawrence and Bullen, 1892.)

THIS is still another elementary manual dealing with the non-metals and their compounds. According to the author it can be studied most advantageously if the rudiments of chemistry have first been acquired. The book is built on pretty much the same plan as many already in existence; here and there, however, the reading is enlivened by ideas which, if not altogether commendable, have some pretensions to novelty.

The author is evidently of opinion that much of the ordinary chemical knowledge can be presented in other ways. Mass and weight first receive attention. In this book there are no atomic weights; atomic masses reign supreme. In using a balance we are told that we do not find weights, but "only masses." Indeed to bring this idea home the following curious question is set:—"When you 'weigh' a thing in an ordinary balance, do you find its weight?"

After a passing allusion to constitutional formulæ, in which they are likened to pyrotechnic frames, the next important alteration with which the author concerns himself refers to the nomenclature of oxides. Such a name as sulphur dioxide or carbon dioxide is discarded, for it is "founded upon a formula which is liable at any time to be altered so as to suit our knowledge of atoms and molecules." Anhydride is described as, "etymologically at least, a still more atrocious term"; hence we find that throughout the book SO_2, CO_2, &c., are spoken of as acids. P_2O_5 is said to be a tribasic acid, N_2O_5 a monobasic acid. CS_2 is called sulphocarbonic acid, P_2S_5 thiophosphoric acid, N_2O hyponitrous acid, and so forth, in spite of the fact that such compounds as that formed from "hydric oxide and phosphoric acid (*sic*) are often called *acids* by modern chemists."

The definition of a salt is thus summarily disposed of:—"You are often asked what a salt is; the only possible answer is that it is a compound."

Such methods of tampering with terms which have a generally-accepted meaning should, it seems to us, meet with no encouragement. They can only end in muddling the reader who wishes to pursue his subject by the aid of any of our standard works. But matter which is liable to do more immediate harm is frequently to be noted. For instance, it is stated that there is no such thing as the Law of Multiple proportions—it is only a corollary of the atomic theory. If, according to its usual interpretation, a law is a generalized statement of fact, it is rather hard to see how its existence is affected by its relations to any theory.

To most chemists the brilliant work of Moissan has sufficed to settle the question of the isolation of fluorine; the author is, however, still sceptical on this point. P_2O_3 is given as the formula of phosphorous acid (*sic*); recent research has shown P_4O_6 to be correct. The valency of potassium is said to have been fixed by a "minute study of its *gaseous* compounds," water is stated to be elastic with regard to *shape*, and from Avrogadro's hypothesis molecules of different gases are stated to be equal in size.

Even when the author is apparently trying to be precise he is apt to mislead. The following definition is an example:—"A chloride means a compound of chlorine with some other substance which, though it is not itself metallic in its general characteristics, possesses that important property of a metal, the capability of uniting *energetically* with chlorine." Is it to be understood from all this that a chlorine compound which is not produced by energetic union—say an endothermic compound like C_2Cl_4—is not a chloride?

These extracts may serve to show that the book requires to be carefully overhauled before it can be placed with confidence in the hands of a beginner.

OUR BOOK SHELF.

Vegetable Wasps and Plant Worms; a Popular History of Entomogenous Fungi, or Fungi parasitic upon Insects. By M. C. Cooke, M.A., LL.D., A.L.S. [364 pp. 4 pl. and figs. in text] (London: S.P.C.K., 1892.)

IT is somewhat surprising that a book on a subject of such importance alike to the entomologist and fungologist has not been forthcoming long ago. It is true that a Memoir on the subject was undertaken thirty-five years ago by Mr. G. R. Gray, but, being privately printed, was limited in circulation. To this work Dr. Cooke admits his indebtedness for a large amount of information bearing on the entomological aspect of the subject, and it is to be regretted that he was not aware of the existence of a much extended manuscript revision of the same work, at present in the Botanical Department, Natural History Museum.

Dr. Cooke's book is professedly a popular work on the subject, and consequently does not deal with the economic side, relating to such matters as the "muscardine" or silkworm disease, further than to indicate the nature and affinities of the fungus causing the disease.

The fungi parasitic upon insects are arranged under four primary groups: the *Cordyceps* group, the *Laboulbeniaceæ*; the *Entomophthoræ*, and lastly a heterogeneous collection of moulds, which, with few exceptions, are not truly parasitic and destructive. The structure and general characteristics of these groups, with glimpses of their life-history, are dealt with in an introductory chapter. Entomologists, whose main interest will be to ascertain the name of any fungus parasitic on an insect, will find this a comparatively easy matter, as the general arrangement is an entomological one, commencing with the Hymenoptera; and under each is given an account of all the fungi that are known to be parasitic upon species included in the order. Numerous woodcuts in the text and four plates assist very materially in the determination of species. From the mycological standpoint the arrangement indicated above is purely artificial, and introduced

for a purpose; while for the benefit of those who desire to know more of the inter-relationship of the fungi enumerated, a classified list is given of all the species, arranged under their respective families, including the distribution and name of the host.

For the general reader, who is not specially interested in either insects or fungi, there is a considerable amount of interesting information bearing on such subjects as vegetable caterpillars, vegetable wasps, foul-brood of bees, &c., and the interest is not lessened by following the transition from the romantic and highly imaginative accounts given by early travellers of these productions, to the statements in accordance with modern knowledge. There is a slip on p. 35; *Cordyceps Sheeringii* should be *C. Sherringii*. The indices are very complete and the figures, excepting one on p. 10, good.

Notes on Qualitative Chemical Analysis. By P. Lakshmi Narasu Nayudu, B.A. (Madras: K. Murugesa Chetty, 1892.)

IT is interesting to meet with books such as this, which serve to indicate how the study of chemistry is progressing in the colonies and dependencies of the empire.

The author sets out with the endeavour to keep the *rationale* of the various processes of qualitative analysis well to the front, as in this way he considers the value of the study as a means of scientific training can alone be brought out. Group-reagents and the reasons for their use are first discussed as a preliminary to a somewhat exhaustive study of the reactions of the different basic and acid radicles. At the end of each group tables are given showing at a glance the behaviour of the radicles towards the various reagents.

It is somewhat astonishing that after such a minute study of the reactions of all the more common radicles, the author should give no schemes for the separation of the constituents of the different group-precipitates. In spite of the fact that under each radicle he gives as many, if not more, reactions than are given in the larger works on qualitative analysis, he contents himself with merely going through the examination of a simple salt. The expenditure of but little space would remedy this omission, which limits the sphere of usefulness of the book. It is to be noted also that film-tests find no place in the system adopted.

It may be said that the author adheres well to his purpose of showing why any particular operation is performed. The book contains a large amount of useful information. Occasionally, however, the mode in which it is stated is peculiar. "In the cold" is an expression commonly used in speaking of a reaction. The use of "in the heat," a term often employed by the author, is, on the other hand, uncommon. To speak, too, of "neutral solutions of zinc salts containing strong acids" is confusing. In some cases, as when using bodies like potassium metantimoniate or sodium hydrogen tartrate, it would be advisable to give the name as well as the formula: it isn't every student who is acquainted with such substances. It is erroneous to say that fluorine does not combine with carbon even at a high temperature. According to Moissan, all the allotropes of carbon, except the diamond, unite with fluorine, indeed some of the forms are, in the cold, spontaneously inflammable in the gas.

The following typographical errors are omitted in the list of errata. On p. 47 "meterially" should be "materially," "gSo_4," &c. should be "$MgSo_4$," &c. on p. 58, and "Ba_2P_2O" is given for "$Ba_2P_2O_7$" on p. 69.

Science Instruments. Catalogue of Scientific Apparatus and Reagents manufactured and sold by Brady and Martin. (Newcastle-on-Tyne, 1892.)

AT the present time, when almost all branches of experimental science are growing so rapidly, and new and improved pieces of apparatus are continually coming into existence, it is satisfactory to find that instrument makers are trying to keep pace with the times, and to afford purchasers the means of ascertaining with the minimum trouble what apparatus can be obtained to serve a particular end. This catalogue is an instance that such is the case. It is a well-bound book, profusely and clearly illustrated. The different kinds of apparatus, useful both for teaching and for technical purposes, are well classified. To prevent mistakes in ordering, each piece of apparatus is separately numbered, and where a new form is figured, a few lines are added explanatory of the principle involved.

The instruments quoted belong to various branches of experimental science—chemistry, bacteriology, physics, mechanics, and meteorology. A selection of instruments made by the Cambride company, and miscellaneous apparatus, diagrams, chemical reagents, &c., are also included.

The sections on bacteriology and gas analysis are especially full, and indicate the interest at present taken in these departments.

A table of contents and an index are supplied. On p. 145 "Irish" is misprinted for "Iris"; and what is termed an "optical bank," on p. 164, is usually called an "optical bench."

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Universities and Research.

AT the discussion in Edinburgh on the proposed National Laboratory, Lord Kelvin and Sir Geo. Stokes took marked exception to my contention that the primary business of Universities was research, contending that it was teaching. In a sense their contention is true, but not in contradistinction to my contention. The distinction would hardly be worth fighting over were it not that they took up the further ground that only those researches should be engaged in in Universities which were likely to interest the students. Of course the leaders of science can if they choose sell the great birthright of Universities for a mess of fees, but I hope they will not be permitted to do so without protest. What view the democracy take of Universities is of the very last importance with our democratic institutions, and I trust all those who have the welfare of the nation at heart will protest against the Universities being turned into coach-houses. In this connection it is most important to bear in mind the distinction between the functions of Universities and those of schools and colleges. The function of these latter is primarily to teach those who resort to them. The function of the University is primarily to teach mankind. In former days, when the means for distributing information were very imperfect, students used to flock from all sides to learn directly from a great mind. Nowadays the great mind distributes his teaching broadcast. In old days the only way to learn what was being done to advance knowledge was to go to the place where knowledge was being advanced. Nowadays we read the Transactions of our learned societies at home. But at all times the greatest men have always held that their primary duty was the discovery of new knowledge, the creation of new ideas for all mankind, and not the instruction of the few who found it convenient to reside in their immediate neighbourhood. Not that I desire to minimize the immense importance of personal influence, it is overwhelming; but it is a question quite beside the one at issue, which is whether the advance of knowledge by research and the teaching of the whole nation by the discoveries made is not rather the primary object of Universities than the instruction of the few students who gather in their halls: that is the real question at issue between Lord Kelvin, Sir Geo. Stokes, and myself. Are the Universities to devote the energies of the most advanced intellects of the age to the instruction of the whole nation, or to the instruction of the few

whose parents can afford them an, in some places fancy, education that can in the nature of things be only attainable by the rich?

In view of the discussion upon the proposed Teaching University for London it is to be hoped that these things will not be overlooked amid the local questions and rival institutions. It is to be hoped on the one hand that those who will have the privilege of learning in the greatest city in the world will not be deprived of the personal influence of its greatest men by relegating these to some haven of laboratories where no bracing breath of students shall interfere with the inmates. On the other hand it is to be hoped that London will so far honour itself as not to be content until it sees its University a centre of thought and investigation from which shall radiate new ideas and discoveries to enlighten and benefit the whole nation. Before I close there is a matter of great importance to which I fear sufficient importance is not attached by those who are directing this matter and that is the great objections there are to mixing up Universities and Colleges with examining boards. We here in Trinity College, Dublin, suffer very much from the fact that a considerable number of our students never reside here, but only come over for periodical examinations. We only suffer in one way, while if London adopted this abominable arrangement it would suffer in two ways. We suffer because our degree is much less valued than it would be if all our students were compelled to reside. All our students have not that education got by friction with their fellows and by contact with trained intellects which no examination can test, and which is such a valuable training, and in consequence our degrees are the less valuable. London would suffer in this way, and it is a very serious way too. In addition to this London would suffer from the inordinate importance that would be attached to extern examiners if the University examined London and extern students. So far we have escaped this danger, but it is inevitable in London because the extern element there would be large, influential and organized, while with us it is of little strength. The result would be to perpetuate and intensify that horrible teaching for examinations which is so necessary an evil in the case of the majority of students, but from which the leaders of thought should be exempt. It matters not that the syllabus nor even that the very questions are approved by the professor, if the examination is conducted to any serious extent by an independent mind. The student will seek a coach, who will probably teach him very well indeed, but whose whole view of learning will be of the passing-an-examination type, and who will infect his pupil with this miserable disease. Gradually the professor himself will be involved in the vortex, and the whole University will gradually look upon the passing of examinations as the end of life for students, and this is the acme of coaching and the bathos of education.

GEO. FRAS. FITZGERALD.

Trinity College, Dublin, November 25.

The Stars and the Nile.

AFTER reading Mr. J. Norman Lockyer's papers on the connection of the orientation of Egyptian temples with the heliacal rising of certain stars, I was interested to find that a custom still exists in the neighbourhood of the Second Cataract having a strong resemblance to the old Egyptian custom.

The Nuba people of this part foretell the first rise of the Nile by the heliacal rising of the Pleiades, or as they call it, "Turáya." For Sirius they have no special name, calling it merely "the driver" or "follower" of the three stars (Orion).

It must be remembered that the first sign of the rise at Wady Halfa occurs at the beginning of June, reaching Assouan about a week later, but for some days the increase is very slow, and scarcely perceptible except in the readings of the Nile gauges.

These Nuba people still preserve in their language many ancient Egyptian words, and possibly we may have here a trace of the old custom, the Pleiades being taken instead of Sirius on account of the earlier date of the rise in the district of the Second Cataract than in Egypt itself.

H. G. LYONS, Capt. R.E.

Cairo, November 14.

A Palæozoic Ice-Age.

THE account by Dr. Wallace in NATURE (p. 55) of glacial deposits recently discovered in Australia is a most important and welcome addition to our knowledge. But to us the surprising circumstance is that Dr. Wallace appears quite unaware of the fact that this is only an addition to a great series of discoveries, by no means confined to Australia, affording evidence of a Palæozoic ice-age. That the deposits near Sandhurst are Palæozoic may, in the absence of any indication to the contrary, be assumed, since they are clearly similar in position and character to the well-known boulder beds of Bacchus Marsh, and these have been correlated with the strata containing ice-borne fragments, amongst the marine beds west of Sydney and also at Wollongong to the southward, and in Queensland to the northward. All these beds have been shown to be upper carboniferous. A good account of the facts known up to 1886 may be found in Mr. R. D. Oldham's paper on the Indian and Australian coal-bearing beds (Rec. Geo. Surv. Ind. xix. p. 39).

It is scarcely necessary to refer to the fact that extensive Palæozoic glacial deposits, of the same age as those of Australia, have been found in several parts of India, some as far within the tropic as lat. 18° N., others in the Salt Range of the Punjab, that the famous Dwyka conglomerates of South Africa are similar and in all probability contemporaneous, and that boulder beds of very possibly the same geological date have been observed in Brazil. We should not have mentioned these but for the fact that the idea of a Palæozoic ice-age is apparently novel to Dr. Wallace. We do not think, however, that the reason why so well-informed a naturalist is unacquainted with geological data long known to many is any mystery. It has become an accepted article of faith amongst most European geologists (there are, of course, exceptions) that no ice-age occurred before the last glacial epoch, just as it is part of the geological creed that the carboniferous flora was of world-wide extension, and as it has become the prevailing belief that the deep oceans have been the same since the consolidation of the earth's crust. Now the discoverers of glacial evidence in the carboniferous beds of India and Australia also assert that the carboniferous flora of those countries differed *in toto* from that of Europe and resembled the jurassic flora of European regions, and some of them add that the great southern flora of South Africa, India, and Australia must have inhabited a vast continent, part of the area of which is now beneath the depths of the Indian Ocean. Partly from Indian and Australian geologists being regarded as heretics geologically, partly from other causes, the evidence of ice-action in India and Australia has been generally ignored. No better proof could be afforded of the fact that European geologists in general have omitted to notice the series of discoveries in the southern hemisphere and in India than the publication of Dr. Wallace's paper.

The glacial evidence as it now stands is extremely interesting and perhaps transcends in importance that of the Pleistocene glacial epoch. For as the effects of the carboniferous ice-age were felt within the present tropics, either the earth's axis of rotation must have shifted considerably, or else the refrigeration of the surface must have been due to a cause distinct from that supplied by the late Mr. Croll's theory, even when supplemented by Sir R. Ball's amendment.

Our own interest in the whole subject is chiefly due to the circumstance that we happened in 1856 to be the first who met with the ancient boulder-bed in India, and suggested that it might be explained by the action of ice. The discoveries in Australia and South Africa were of course quite independent of those in India, but were, we believe, slightly later in date.

November 20.

W. T. BLANFORD.
HENRY F. BLANFORD.

Geology of Scotland.

MAY I supplement Prof. Green's history of geological mapping in Scotland (NATURE, vol. xlvii. p. 49) by pointing out that Mr. Cruchley published, on March 23, 1840, "A Geological Map of Scotland by Dr. MacCulloch, F.R.S., &c., published by order of the Lords of the Treasury by S. Arrowsmith, Hydrographer to the King." This fine map is on the scale of four miles to an inch. From the omission of "the late" before MacCulloch's name, it seems possible that the plates were in course of engraving before his death in 1835.

GRENVILLE A. J. COLE.

Royal College of Science for Ireland, Dublin.

British Earthworms.

I ENTIRELY concur with Dr. Hurst's view that the supposed new pecies, described by the Rev. Hilderic Friend as *L. rubescens* is in reality Savigny's *L. festivus*. I may add a further reason for discarding the term *L. terrestris*, Lin., and substituting *L. herculeus*, Sav., for our common large worm. Savigny himself used "Enterion terrestre" to indicate a worm differing considerably from *L. terrestris*, Lin., in the position and extent of the clitellum; moreover it belongs to the genus *Allolobophora* and not to *Lumbricus* at all.

With regard to the second "new" species, *A. cambrica*, recently described by Mr. Friend, I believe that it is merely a variety of *A. chlorotica*, Sav.

According to the description it *appears* to differ from the latter species in three points:—(1) colour; (2) extent of clitellum; (3) number of spermathecæ.

(1) Now, amongst my collection of British worms I find one, of which a water-colour sketch taken from the living specimen closely resembles Mr. Friend's description of the colour of *A. cambrica*. My notes as to size, habits, &c., agree with his description. I have carefully re-examined my specimen, and find that it agrees perfectly with *A. chlorotica*; or, in other words, I find that *A. chlorotica* may vary—as Hoffmeister knew that it did vary—so much as to resemble *A. mucosa*, and I may suggest that it is a mimetic resemblance.

(2) Further, with regard to the clitellum of *A. chlorotica*: in the table given by the Rev. Hilderic Friend, it is stated to cover somites 29–36. As a matter of fact the next somite, 37, is nearly always included. This brings *A. cambrica*, Friend, into harmony with *A. chlorotica*, Sav.

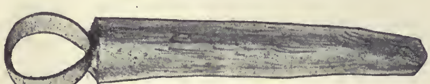
(3) Thus the only differential character left is the number of spermathecæ; and I cannot agree to the validity of a new species on this single character; several specimens should be examined to settle the point, as variation in this feature is known to occur.

I take a certain amount of credit to myself for the useful faunistic studies on the earthworms of Great Britain, now being pursued by the Rev. Hilderic Friend, for, if I mistake not, I put him in the way of recognizing their specific characters, when, some years ago, I named for him, with remarks thereon, sundry consignments of some scores of worms which he sent to me for that purpose. WM. BLAXLAND BENHAM.

The Dept. of Comparative Anatomy, Oxford, November 21.

Egyptian Figs.

THE accompanying sketch represents an instrument used in Egypt for removing the "eye" or top of the sycomore fig. It is a piece of hoop iron, blunt on one edge and tolerably sharp on the other, and fixed into the end of a stick. The fruit of *Ficus sycomorus*, or "Egyptian fig," seems to be invariably infested with the insect *Sycophaga crassipes*, Westw.; which I am informed by Rev. T. F. Marshall, who has kindly given me the name, is the same insect supposed to effect caprification in Malta, judging from specimens which I sent him. This fig never produces ripe seed in Egypt, though it has been introduced from the earliest times. Not only are the ancient coffins made of the wood, but it was adopted as the sacred "Tree of Life.



It probably came from Yemen, where Dr. Schweinfurth saw many seedling trees growing spontaneously. The tree bears three crops per annum, in May, June, and August—September. Boys cut off the top of the figs of the first two crops only. Dr. E. Sickenberger, one of the professors in the School of Medicine, Cairo, informs me that the figs have no pleasant flavour until the operation has been performed:—"They then become very sweet, but remain smaller than when not cut open. The object is *to let the insects escape*. Those that are left become watery and tasteless, and are full of *namoos* or sycophaga." In his first description Dr. Sickenberger described the instrument as "a kind of thimble made of iron plate ending in a spatula like a finger-nail. It is fixed on the thumb of the right hand. The operation is only made on fruits which shall be picked up the following day. The day after the operation the fig is quite ripe. The male flowers in those figs are all aborted, and the females have never perfect seeds. The figs of the third generation are larger, of an agreeable taste, and sweet-scented; but they are not operated upon, only because in August and September, though the trees are much fuller of fruit than in May and June, the people have so much to do at that time. They are seldom sold, and only eaten by the owners of the trees, or else they are abandoned to the field-mice, birds, and dogs, which latter are very fond of them. These *nilg* fruits are full of sycophaga."

It will be seen that the instrument he has sent me is of a different shape to the one he describes; and the chief interest lies in the fact that Pliny also describes the process as closely corresponding with this modern method. He even uses a similar term "nail" (ὄνυχας): *πέπτειν οὐ δύναται ἂν μὴ ἐπικνισθῇ· ἀλλ' ἔχοντες ὄνυχας σιδηροῦς ἐπικνίζουσιν· ἃ δ' ἂν ἐπικνισθῇ, τετάρταια πέπτεται* (*Nat. Hist.* xiii. 14). Further, the Prophet Amos describes himself as *bōlās siqmīm*; and the authors of the LXX, writing in Alexandria, appear to have understood the expression and translated these words by *κνίζων συκάμινα*. This is the same verb as that which Pliny uses; so that it would seem to be pretty certain that Amos performed identically the same operation on the figs as is still done in Egypt at this day. It will be noticed that the idea was to ripen the figs. It does not really do this, because there are no seeds; but it does make the fig sweeter. It also liberates the insects, and without doing this the figs would be uneatable. Jerome is the only author, as far as I know, who alludes to "grubs" being inside the fig.

GEORGE HENSLOW.

Iridescent Colours.

THE article "Iridescent Colours" on p. 92 puts me in mind of a notice which I published thirty years ago, while I lived in the United States. It was entitled "Harmonies of Form and Colour" (*Stettiner Entom. Zeitung*, 1862, pp. 412–414), and a portion of it refers to the subject of the above-mentioned article in NATURE, and may be of interest to its readers:—

"A fundamental observation, which proves the influence of the intensity of light upon colour, may be made on some insects of metallic coloration, inhabiting a large area from north to south. About six years ago, while in Southern Russia, I took a walk during sunset, and was struck by the brilliancy of some metallic red *Chrysomelæ*, abundant in that locality. I found that it was the common *C. fastuosa*, which I did not recognize at once, because in the environs of St. Petersburg, where I lived at that time, it occurs in its metallic-green variety, with an iridescent blue stripe on each of the elytra. Still farther north it assumes a more violet metallic colour. The same is the case with *Chrysomela cerealis* and *C. graminis*. The first of these species is represented in St. Petersburgh in the blue variety (*C. ornata*, Ahrens), while the typical variety, occurring farther south, has purplish-red metallic stripes. It is evident therefore that the metallic colouring of these wide-spread species is gradually intensified from north to south, in the order of the colours of the spectrum. We may imagine the area which these beetles occupy, like an immense rainbow, reflected from their backs, violet in the north, red in the south; the violet perhaps connected in some way with the magnetic phenomena prevailing in the polar regions. The longicorn beetle (*Callidium violaceum*) undergoes the same variation: violet in the north, blue in central Europe." C. R. OSTEN SACKEN.

Heidelberg, Germany, November 27.

The Afterglow.

THERE has been for three weeks past a very remarkable renewal of the afterglow. There is a quite deep secondary red glow after the stars are fully out. I should say that no such afterglow has been seen since 1886, or three years after the Krakatão eruption. There is also a great extension of the white hazy atmospheric corona around the sun, very marked also around the moon. I am unable, however, to make out any of the pink colour on the outer edge of the haze, which was so char-

acteristic of "Bishop's Ring," and distinguishable at Honolulu for two years. Apparently there has recently been a great reinforcement added to the material in the upper atmosphere, which produces the afterglows.

Is this owing to the August eruption in Alaska, which is said to have distributed ashes at a distance of 250 miles?

Prof. C. J. Lyons, in charge of tidal observations in Honolulu, reports the period of highest mean tide to have extended itself this year into November, or fourteen months later than the last similar period. The mean sea level is now over ten inches higher than it was last April. It is also somewhat higher than has been shown by any previous tide registers in Honolulu. Mr. Lyons regards this as of special importance, taken in connection with the oscillation of the earth's axis, now established by the combined observations at Berlin and Honolulu.

Honolulu, November 8. SERENO E. BISHOP.

OSMOTIC PRESSURE.

OF the various properties which have found a common explanation in the new theory of solutions, there are none perhaps to which more interest attaches than to osmotic pressure; and although, on account of the experimental difficulties, the observations as yet accumulated on this subject are but scanty, they have so largely contributed to the novel ideas involved in the new theory, that they merit special attention.

Since accounts of osmotic pressure are finding their way into few English text-books, it may be worth while glancing at the main features which have led up to the present state of the question.

It has long been known that if an aqueous solution—say, of sugar—be separated from pure water by a piece of animal membrane, that movements of the water and of the sugar take place through the membrane. If the solution be contained in an open vessel, the base of which is composed of membrane, on partially immersing the vessel in water it is easy to see that more water enters the vessel than solution leaves it. The level of liquid within rises above that without the vessel, different pressures being thus set up on opposite sides of the membrane.

To this process wherein currents pass through a membranous septum, the terms "osmosis," "osmose," and "diosmose" have been applied. The last of these is perhaps to be preferred, as it serves to indicate that two currents are involved in the phenomena. Investigations carried out as indicated above were concerned with the measurement of what was termed the "endosmotic equivalent." That is the ratio of the amount of water passing *into* the solution to the amount of dissolved substance passing in the opposite direction. Consistent measurements of this quantity could not be obtained, however, for it was found that the nature of the membrane exercised a marked influence upon its magnitude. The kind of membrane employed, or, with the same membrane, its thickness or freshness, or even the direction in which water passed through it, was of importance. Thus in illustration of the last point, water passes more readily outwards through eel's-skin, more readily inwards through frog's-skin.

To obtain quantitative relations in this field it thus became essential to eliminate the influence of the membrane, and more recently this end seems to have been attained by the use of membranes artificially prepared.

These artificial membranes differ from those of animal origin in the remarkable particular that although they allow water to pass through, they present a barrier to the passage of certain dissolved substances. On this account they have been termed semi-permeable membranes, and by their use measurements of osmotic pressure have been made possible.

To carry out such measurements the first point to be solved was to obtain a membrane of sufficient strength. The substance which has been found to be most satisfactory as a membrane-former is copper ferrocyanide. When aqueous solutions of potassium ferrocyanide and copper sulphate are carefully brought into contact a pellicle of copper ferrocyanide is formed where the two solutions meet. In this condition the pellicle is much too fragile to sustain even slight differences of pressure; but by the following simple device, employed first of all by W. Pfeffer, satisfactory results have been obtained.

If a cell similar to the ordinary porous pot of a voltaic battery be lowered into a solution of copper sulphate while at the same time a solution of potassium ferrocyanide be poured into its interior, the two solutions meet somewhere within the walls of the cell and deposit a film of copper ferrocyanide. Little diaphragms of membrane are thus produced stretching across the pores of the cell-wall, which furnishes the necessary support, and by taking suitable precautions a membrane may thus be obtained capable of withstanding a pressure of several atmospheres.

The behaviour of a solution when separated from pure solvent by such a semi-permeable membrane differs markedly from what takes place when an animal membrane is employed. In the latter case, at the outset water adds itself to the solution; the level of liquid and the pressure on the solution-side of the membrane thus rise until a maximum pressure-head is attained, which, roughly speaking, is greater the stronger the solution used. Seeing, however, that dissolved substance is continually escaping from the solution through the membrane, as soon as the maximum is reached the pressure-head begins to fall until eventually it vanishes, the levels of liquid on either side of the membrane being the same.

If, on the other hand, a semi-permeable membrane be employed, as before, a maximum pressure is attained; but since dissolved substance cannot leave the solution, this maximum pressure as well as the concentration of the solution remain constant.

When this constant state of things is established the excess of pressure on the solution-side of the membrane over that on the solvent-side, whatever it may mean, is termed the "osmotic pressure" of the solution. It is therefore customary to reserve the term osmose to phenomena relating to semi-permeable membranes; diosmose being used in cases where, as with animal membranes, dissolved substance as well as solvent can traverse the membrane. It is obvious that when the pressure is established as indicated above, the original concentration of the solution has been altered by the entrance of solvent, and the observed osmotic pressure refers of course to the solution having the final concentration. If, however, we imagine the vessel containing the solution to be closed at the top, a quantity of air being imprisoned over the solution, pressure may be set up by compressing this air, only a small quantity of solvent being allowed to enter. If, further, the air enclosure be tapped by a manometer, measurements of the pressure may be taken, and by making the air enclosure and the volume of the manometer small enough the quantity of solvent entering while pressure is being established may be neglected, the original concentration of the solution remaining practically unaltered. This is the principle of the method employed in measuring osmotic pressure in absolute units.

The question now arises, "Are these measurements really independent of the nature of the membrane? Has the difficulty which beset the older experiments been overcome?" To this question an immediate answer is forthcoming, for, as pointed out by Prof. Ostwald, it follows from theoretical considerations that if the membrane employed is really semi-permeable, the observed osmotic pressure of a given solution must be the same, no matter of what material the membrane is com-

posed. For suppose we have a quantity of solution enclosed in a tube, one end of the tube being closed by a membrane A, the other by a membrane B, and suppose it possible that a pressure P can be developed on the membrane A when it separates the solution from pure water, which is higher than the pressure *p* similarly developed when B separates the solution from pure water. On immersing the tube in water, the latter will begin to pass through both membranes into the solution. When the pressure *p* is attained passage through B will stop, but that through A will continue; but as soon as the pressure on the solution rises above *p*, water will be forced out through B. The pressure P will thus never be attained, water will continuously enter through A, and pass out at B. We will thus have a machine capable of doing an infinite amount of work, which is impossible. Similar reasoning shows that *p* cannot be greater than P; it follows therefore that the pressure developed on each membrane is the same, that the osmotic pressure must be independent of the nature of a truly semi-permeable membrane.

Actual observations are on record in which the osmotic pressure did appear to vary with the membrane employed. A sugar solution, for example, exhibited a much lower osmotic pressure with a membrane of Prussian blue or calcium phosphate than with copper ferrocyanide. From the preceding argument it is concluded, however, that these membranes giving the lower values were not quite firm or not quite impermeable to the dissolved substance; the highest value is thus taken as the measure of the osmotic pressure which is nearest the truth.

On glancing at the results which have been obtained, the first point which strikes one is the extraordinary magnitude of the pressures thus set up. In the case of a 1 per cent. aqueous solution of nitre the pressure attains the value of 2½ atmospheres. This value increases with the strength of the solution till at 3·3 per cent. it is no less than 6 atmospheres, this pressure being the highest which any membrane yet prepared has been able to withstand. With substances like sugar, other things being the same, the pressure is not so great, but in all cases, in order to keep it within workable limits, the solutions employed have to be dilute.

Striking as the results are themselves, their explanation is not less remarkable. The original measurements of osmotic pressure were made with the purpose of elucidating the movement of liquids in plant cells, and naturally the substances examined were such as occur in the vegetable organism—aqueous solutions of sugar, gum, dextrin, and the nitrate, sulphate, and tartrate of potassium. For some years after these observations were made, they lay comparatively unnoticed, until Prof. van't Hoff, of Amsterdam, turned them to a use undreamt of by their discoverer. From a study of the properties of dilute solutions van't Hoff came to the conclusion that the osmotic pressure was due to the bombardment of the molecules of the *dissolved substance* on the semi-permeable membrane. For when the osmotic pressure is established and equilibrium exists between solvent and solution, in the same time, equal amounts of solvent, must pass in either direction through the membrane and the impacts of the solvent molecules on the membrane will then be equal and opposed on either side, and therefore negligible. On this reasoning the pressure recorded on the manometer is taken to be that exerted by the substance in solution.

On examining the magnitude of the pressure thus attributed to the dissolved substance, in the case of a solution of sugar van't Hoff next showed that it bore the closest resemblance to the pressure of a gas. Indeed, if we calculate the pressure of a gas which at the same temperature contains as many molecules per unit volume as there are molecules of sugar per unit volume of solution, then the pressure of the gas and the osmotic pressure are the same. Moreover, on thermodynamical grounds it was established that on the above hypothesis as to the nature of osmotic pressure its magnitude should be quantitatively connected with measurements of other physical properties of solutions, more especially those on the lowering of the vapour-pressure, and of the freezing point of a solvent produced by the presence of dissolved material. In this way a mass of evidence was collected, a general survey of which led to the foundation of the new theory of solutions. On this theory the dissolved substance, if the solution be dilute, is supposed to behave as if it were gaseous, the pressure it exerts—the osmotic pressure—being equal to the pressure which it would exert if it were gasified, and occupying, at the same temperature, a volume equal to the volume of the solution.

Unfortunately measurements of osmotic pressure have only been made on few substances, and only for solutions in water, but on turning to all the available observations to see how they support this novel conclusion, the most superficial examination serves to show that an agreement does not exist. Unless in the case of sugar, for no substance of known formula which has yet been investigated does the osmotic pressure agree with the corresponding gaseous pressure. These substances consist of salt solutions, and they invariably give higher osmotic pressures than theory demands. Similar disturbing influences have been observed when other physical properties of these solutions were measured, and to account for the facts an additional hypothesis has been put forward by Dr. Svante Arrhenius.

Salt solutions are electrolytes, they conduct the electric current, and undergo simultaneous chemical decomposition into their constituent ions. Experiment shows that such electrolytic solutions give high osmotic pressures, more particles appear to bombard the semi-permeable membrane than if the dissolved substance behaved as a gas. The new hypothesis states that this is really the case, the additional number of particles being produced from the breaking up of the dissolved substance. It states that in a solution which can be electrolyzed a portion at least of the dissolved substance exists already decomposed or dissociated into its ions, and that although these ions cannot be separated by diffusion they are so far independent that each can exercise an effect on the semi-permeable membrane.

The extent of this electrolytic dissociation is supposed to vary with the chemical nature of the dissolved substance, and to increase with the dilution. In very dilute solutions it may be complete, the whole of the dissolved substance being supposed to exist in the state of ions.

The second hypothesis gives, therefore, some explanation why the osmotic pressure of a salt solution is greater than that of a non-electrolytic solution of sugar; it further fixes the limits between which the osmotic pressure ought to vary in the case of an electrolyte, for the lower limit should be that of undissociated gas, the higher should be that of completely dissociated gas, each original molecule having decomposed into as many submolecules as there are ions in each molecule of salt.

So far as these limiting conditions go, the facts support the hypothesis. In all cases the observed osmotic pressure is either equal to one or other of the limits, or lies between them. A closer scrutiny leads, nevertheless, to apparent discrepancy. It is evident that a measure of the amount of dissociation can be obtained from osmotic pressure observations. For if we divide the observed osmotic pressure by the corresponding pressure of undissociated gas we have obviously, if the preceding hypotheses are valid, the ratio of the actual number of bombarding molecules to the theoretical number had no dissociation occurred. The ratio of these two numbers is denoted by the letter "*i*," a factor first used by van't Hoff. Now, on the new theory, the value of "*i*" can be

obtained by measurements of other properties of salt solutions, the electric conductivity, the depression of the freezing point, &c., and the theory is compared with practice by seeing if the values of "i," as determined, say, from freezing-point observations, agree with those deduced from the osmotic pressure. The comparison shows that in some cases, some half-a-dozen in all, the two sets of values correspond; in others, and in by far the majority, no such correspondences exist. In these latter instances it is argued, and with a certain amount of experimental evidence, that the salts were not without action on the membrane employed, and that, therefore, diosmose really took place, the membrane was not truly semi-permeable. In this way the discordant observations have been put out of court.

It is thus apparent that the leading hypotheses of the new theory do not receive confirmation of the weightiest kind from observations on osmotic pressure. Indeed, were they supported by such measurements alone, they would hardly be entertained. Their mainstay, however, ies in the mass of experimental work on many other properties—evidence which it is much easier to obtain than the difficult measurements on osmotic pressure—which has been correlated and explained by their use.

It is only fair to add that both hypotheses, from physical as well as chemical standpoints, have met with a measure of adverse criticism. The *rôle* played by the membrane has also been questioned. It has been suggested that it is not really semi-permeable, allowing solvent only to pass, but just as a porous plug behaves towards a mixture of gases, it allows molecules with different momenta to traverse it at different rates. Or, again, its action has been likened to that of a palladium film towards hydrogen, compounds being formed with the membrane substance on one side, these becoming diffused and dissociated on the other. If either of these views be correct the pressures exerted by dissolved substances have probably never been measured.

On the other hand, important theoretical support has been put forward in favour of the gaseous analogy. Several physicists, starting from entirely different points of view, have arrived at the result that in a dilute solution the dissolved substance should obey laws similar to those which hold for gases. At present the attitude of the prominent upholders of the new theory is one of indifference as to the exact mechanism of osmotic pressure. The numerical agreement between the measurements on solutions and those on gases is regarded as ample justification for considering dissolved substances to be in a *pseudo*-gaseous condition.

Whatever the ultimate explanation of the facts may be, there can be no doubt that the existing speculations on the nature of osmotic pressure and allied phenomena have infused new life into the study of solutions. Indeed, as instigators to fresh inquiry these hypotheses must take rank as the most fruitful of recent times.

J. W. RODGER.

A SANITARIAN'S TRAVELS.

MR. ROBERT BOYLE has travelled round the world no fewer than four times for the purpose of studying sanitary science and preparing the way for the introduction of the ventilating and sanitary appliances he has invented. An interesting account of his fourth journey is given in a little book entitled "A Sanitary Crusade through the East and Australasia," consisting of a series of papers reprinted from the *Building News*. In the course of this "crusade" Mr. Boyle visited Burmah, the Malay native states, Sumatra, Siam, Borneo, Java, Australia, New Zealand, Samoa, the Sandwich Islands, and America. Of all the facts noted by him as a sanitarian the most remarkable are those relating to leprosy, a disease which he believes to be spreading to an alarming extent all over the world. He was particularly struck by the gigantic proportions the evil has assumed in Burmah. The steps of the great Shwedagon pagoda at Rangoon, the Mecca of the Indo-Chinese Buddhists, he found to be

GREAT RECUMBENT FIGURE OF BUDDHA, PEGU, BURMAH.

"closely lined from top to bottom with lepers, suffering from that loathsome disease in its worst forms and most advanced stages." A number of the victims examined by Mr. Boyle "presented a most sickening and awful spectacle." Yet no provision worthy of the name appears to be made for the maintenance or treatment of these poor lepers, who are thus compelled to resort to begging to keep themselves in existence. At Mandalay Mr. Boyle came in contact with horrors of a similar nature. During times of high festival the entrances of the great Arakan pagoda in that city are crowded by hundreds of lepers, so that the visitor has to pick his way carefully among them. In the Sandwich Islands also Mr. Boyle was strongly impressed by the terrible effects of the curse of leprosy, which, he says, has nearly decimated the native population.

He has a curious theory to the effect that the propagation of leprosy has been to a large extent connected with cannibalism, the disease "being spread wholesale through the eating of infected bodies." He has frequently seen in New Caledonia and the South Sea Islands human bodies "hanging up in the natives' huts, intended for future repasts, though then in an advanced stage of decomposition and exhaling a sickening odour."

The little book is by no means occupied only with these terrible subjects. Reference is made to many interesting things which came under Mr. Boyle's observation in the course of his journey. We may especially note the impression produced upon him by Buddhist temples and various classes of objects associated with Buddhism in Burmah. Pagan, an ancient capital of Burmah, situated on the Irrawaddy between Mandalay and Rangoon, contains an enormous number of Buddhist temples of various sizes and styles of architecture, and the city, as seen from the river, is described by Mr. Boyle as "one of the grandest and most impressive sights he has ever seen." Lower down the Irrawaddy below Prome there is a cliff about two miles long and 300 feet high, on the face of which are carved innumerable figures of Buddha ranged in tiers from the bottom to the top. He thinks that some of these figures cannot be less than twenty feet high. Many of them are richly gilded, and the whole forms "a very brilliant and curious sight." We reproduce an illustration showing the great recumbent figure of Buddha, in the province of Pegu, of which Mr. Boyle reports that "it is said to measure about 270 feet in length by 70 feet at the shoulder." In a paper read lately before the Anthropological Institute (see NATURE, November 10, p. 46) Major R. C. Temple gives the length as 181 feet and the height at the shoulder as 46 feet. This remarkable monument is built of brick, and Major Temple speaks of it as "well proportioned throughout." It is supposed to have been produced in the fifteenth century. It was hidden from view by jungle until 1881, when it was accidentally discovered by a railway contractor.

GAUSS AND WEBER.

IN bringing before our readers the contents of a circular we have received with respect to the erection of a monument, in Göttingen, to the two world-renowned scientific workers and friends, Charles Frederick Gauss and William Weber, we do so, knowing that every scientific man, whether he be astronomer, mathematician, or physicist, will be only too glad to have a chance of paying some tribute, however slight, to their memory.

Only about a year has gone by since the younger of the two, William Weber, passed away, having brought glory to the University of Göttingen, which was radiated throughout the whole scientific world. The work which both have done in the service of science cannot be said to be the property of their followers alone, but is a precious heirloom of mankind, which has proved, and will continue to prove in the future, valuable in many ways in the service of technics, in methods of communication, and in civilization generally.

Gauss, who is almost unequalled among the scholars of the century, has not only left imposing landmarks of his great mind in all domains of pure mathematics, but he has also by his work furthered all departments of its applications in astronomy and physics, while his investigations have become standard for the theoretical as well as for the observational side.

What Gauss did for magnetism, Weber, whom Gauss had chosen for his fellow-worker, attracted by his useful work on acoustics, did for the strength of galvanic currents, for their impelling electromotive forces, and for their resistances.

Further, in teaching how to measure these quantities in absolute units, he has furnished extremely important methods for their investigation. In this way not only has the science itself been furthered, but a firm basis for the development of electro-technics has been formed, the soundness of which is proved by its general adoption and which has contributed greatly to the tremendous advance witnessed during the last ten years. The pamphlet then goes on to say: "It is not the purpose of these lines to enlarge on the eminent works which we owe to the co-operation of these great investigators; we can only call to mind the fertile researches on the laws of the earth's magnetism, from which as it were a new branch of physics has developed; further, the attempts to encompass the phenomena of electrostatics, electrodynamics, and induction by one single law, attempts which, however a future generation may judge of them, will mark an important epoch in scientific development; and further, we may recall the most popular result of their co-operation, viz. the erection of the first telegraph practically adopted for communication at a distance."

Since the year 1877 the birthplace of Gauss has possessed a memorial of him, but Göttingen, the place where he and Weber worked, and where the former died, and which consequently became celebrated, possesses no such memorial. That this should be remedied is the object of this circular, and one has only to glance down the list of names attached to it—about 275 altogether—to see that it includes most of the learned men in Germany, and those of many distinguished foreigners. Among these we are glad to see the name of Lord Kelvin, President of the Royal Society.

The acting committee is composed of Prof. Klein, E. v. Meier (Curator of the University), F. Merkel (Prorector of the University), G. Merkel (Over-burgomaster), Profs. E. Riecke, E. Schering, W. Schur, W. Voigt, H. Weber, and S. Benfey (banker), and it is to the last mentioned that subscriptions should be addressed (S. Benfey, Bankgeschäft, Göttingen). The list will remain open until April 1, 1893.

THE ANNIVERSARY OF THE ROYAL SOCIETY.

YESTERDAY being St. Andrew's Day the anniversary meeting of the Royal Society was held in their apartments at Burlington House. The auditors of the Treasurer's accounts having read their report, and the Secretary having read the list of Fellows elected and deceased since the last anniversary, the President (Lord Kelvin) proceeded to deliver the anniversary address. The medals were then presented as follows:—The Copley Medal to Prof. Rudolf Virchow, For.Mem.R.S. (received by the Foreign Secretary), for his investigations in Pathology, Pathological Anatomy, and Prehis-

toric Archæology; the Rumford Medal to Mr. Nils C. Dunér (received by the Swedish Minister), for his Spectroscopic Researches on Stars; a Royal Medal to Mr. J. N. Langley, F.R.S., for his work on Secreting Glands, and on the Nervous System; a Royal Medal to the Reverend Prof. Pritchard, F.R.S., for his work on Photometry and Stellar Parallax; the Davy Medal to Prof. François Marie Raoult, of Grenoble, for his researches on the Freezing Points of Solutions, and on the Vapour Pressures of Solutions; and the Darwin Medal to Sir J. D. Hooker, F.R.S., on account of his important contributions to the progress of Systematic Botany, as evidenced by the "Genera Plantarum" and the "Flora Indica," but more especially on account of his intimate association with Mr. Darwin in the studies preliminary to the "Origin of Species."

The Society next proceeded to elect the Officers and Council for the ensuing year. The following is a list of those elected:—President: The Lord Kelvin. Treasurer: Sir John Evans. Secretaries: Prof. Michael Foster, The Lord Rayleigh. Foreign Secretary: Sir Archibald Geikie. Other Members of the Council: Capt. William de Wiveleslie Abney, Sir Benjamin Baker, Prof. Isaac Bayley Balfour, William Thomas Blanford, Prof. George Carey Foster, Richard Tetley Glazebrook, Frederick Ducane Godman, John Hopkinson, Prof. Joseph Norman Lockyer, Prof. John Gray McKendrick, William Davidson Niven, William Henry Perkin, Rev. Prof. B. Price, The Marquis of Salisbury, Adam Sedgwick, Prof. William Augustus Tilden.

In the evening the Fellows and their friends dined together at the Whitehall Rooms, Hôtel Métropole.

The following is the address delivered at the anniversary meeting by Lord Kelvin:—

Since our last Anniversary Meeting, the Royal Society has lost 27 Fellows on the Home list, and 5 Foreign Members, a sadly great number.

Pedro (Dom) II. (d'Alcantara), Emperor of Brazil, December 5, 1891.
Ramsay, Sir Andrew Crombie, December 9, 1891, aged 77.
Stas, Jean Servais, December 13, 1891, aged 78.
Bennett, Sir James Risdon, December 14, 1891, aged 82.
Devonshire, William Cavendish, 7th Duke of, December 21, 1891, aged 83.
Russell, William Henry Leighton, December 28, 1891, aged 68.
Kronecker, Leopold, December 29, 1891.
Wood, John, December 29, 1891, aged 66.
Airy, Sir George Biddell, January 2, 1892, aged 90.
Henry, William Charles, January 7, 1892, aged 88.
Quatrefages de Bréau, Jean Louis Armand de, January 12, 1892, aged 81.
Adams, John Couch, January 21, 1892, aged 72.
Paget, Sir George Edward, January 29, 1892, aged 83.
Caird, Right Hon. Sir James, February 9, 1892, aged 76.
Dittmar, William, February 9, 1892, aged 59.
Grant (Lieut.-Col.), James Augustus, February 11, 1892, aged 65.
Hunt, Thomas Sterry, February 12, 1892, aged 66.
Bates, Henry Walter, February 16, 1892, aged 67.
Hirst, Thomas Archer, February 16, 1892, aged 61.
Kopp, Hermann Franz Moritz, February 20, 1892, aged 75.
Gregory, Right Hon. Sir William Henry, March 6, 1892, aged 75.
Knowles, Sir Francis Charles, March 19, 1892, aged 90.
Bowman, Sir William, Bart., March 29, 1892, aged 76.
Hofmann, August Wilhelm von, May 5, 1892, aged 74.
Thomson, James, May 8, 1892, aged 71.
Bramwell, George William Wilsher, Lord, May 9, 1892, aged 84.
Aitken, Sir William, June 25, 1892, aged 67.
Schorlemmer, Carl, June 27, 1892, aged 58.
Clark, Frederick Le Gros, July 19, 1892, aged 82.
Sherbrooke, Robert Lowe, Viscount, July 27, 1892, aged 81.
Sutherland, George Granville William Sutherland-Leveson-Gower, Duke of, September 22, 1892, aged 64.
Tennyson, Alfred, Lord (Poet Laureate), October 6, 1892, aged 83.
Calver (Captain), Edward Killick, October 28, 1892.
Biographical notices will appear in the Proceedings.

During the past year, in the mathematical and physical section of the "Philosophical Transactions," eighteen papers have been published, and in the biological section, eleven; the two sections together containing a total of 1235 pages of letterpress and 50 plates. Of the "Proceedings," fourteen numbers have been issued, containing 1223 pages and 20 plates. This unusually large bulk is partly accounted for by the publication in the "Proceedings" of certain extra matters which the Council deemed likely to interest the Fellows. One part (No. 307), which forms an appendix to volume l., contains results of the Revision of the Statutes, to which I alluded in my Anniversary Address last year. It consists of a summary of the second and third chapters, and a copy of the Statutes as now revised, followed by an interesting note on the history of the Statutes, which has been drawn up by our senior secretary, Prof. Michael Foster. In addition to these matters, the same number contains a complete list of the portraits and busts at present in the apartments of the Society, compiled by order of the Library Committee, a work which was much needed, as no such list had been made since Weld's Catalogue, printed thirty-two years ago. The new "list" is not a descriptive catalogue, but the names of the painters and donors, and the dates of the gifts, so far as a thorough and somewhat laborious examination of the Council minutes and Journal books has revealed them, are furnished. The list of portraits is followed by a full descriptive catalogue of the medals at present in the possession of the Society, which has been carefully made by our clerk, Mr. James, under the supervision of the treasurer.

Another extra number of the "Proceedings" (No. 310) is devoted to a First Report of the Water Research Committee on the Present State of our Knowledge concerning the Bacteriology of Water, by Profs. Percy Frankland and Marshall Ward. It contains 96 pages, full of most valuable information regarding the vitality of micro-organisms in drinking water, to which in a large measure the spread of Asiatic cholera, typhoid fever, and other zymotic diseases is now known to be due.

In my Presidential Address of last year, I referred to this Water Committee as having been appointed by the Royal Society, in alliance with the London County Council; and this first instalment of its work seems amply to justify its originators in their expectations of results, most valuable for the public health, from the investigation which has been commenced.

A third extra number (No. 311) contains the report of the Committee on Colour Vision. This Committee, from the time of its appointment in March, 1890, held over thirty meetings, in course of which it examined more than 500 persons as to their colour vision, and tried various methods and many kinds of apparatus for colour testing. The report of the results of the whole inquiry contains a large mass of most interesting matter, and the Committee's work ends in a set of practical recommendations, from which we may hope that much benefit will come, in the prevention of inconvenience and disaster liable to be produced by mistake of colour signals, both at sea and on railways.

Mr. Ellis's communication (Roy. Soc. Proc., November, 1892, vol. lii., p. 191) to the Royal Society of last May, and Prof. Grylls Adams' communication (Phil. Trans., vol. clxxxiii. 1891–92, p. 131) of June, 1891, both on the subject of simultaneous magnetic disturbances found by observations at magnetic observatories in different parts of the world; the award of a Royal medal two years ago to Hertz, for his splendid experimental work on electro-magnetic waves and vibrations; and Prof. Schuster's communication (Phil. Trans. vol. clxxx., 1889, p. 467) to the Royal Society, of June, 1889, on the "Diurnal Variations of Terrestrial Magnetism," justify me in saying a few words on the present occasion regarding terrestrial magnetic storms, and the hypothesis that they are due to magnetic waves emanating from the sun.

Guided by Maxwell's "electro-magnetic theory of light," and the undulatory theory of propagation of magnetic force which it includes, we might hope to perfectly overcome a fifty years' out-

standing difficulty in the way of believing the sun to be the direct cause of magnetic storms in the earth, though hitherto every effort in this direction has been disappointing. This difficulty is clearly stated by Prof. W. G. Adams, in the following sentences, which I quote from his Report to the British Association of 1881 (p. 469) "On Magnetic Disturbances and Earth Currents":—"Thus we see that the magnetic changes which take place at various points of the earth's surface at the same instant are so large as to be quite comparable with the earth's total magnetic force; and in order that any cause may be a true and sufficient one, it must be capable of producing these changes rapidly."

The primary difficulty, in fact, is to imagine the sun a variable magnet or electro-magnet, powerful enough to produce at the earth's distance changes of magnetic force amounting, in extreme cases, to as much as 1/20 or 1/30, and frequently, in ordinary magnetic storms, to as much as 1/400 of the undisturbed terrestrial magnetic force.

The earth's distance from the sun is 228 times the sun's radius, and the cube of this number is about 12,000,000. Hence, if the sun were, as Gilbert found the earth to be, a globular magnet, and if it were of the same average intensity of magnetization as the earth, we see, according to the known law of magnetic force at a distance, that the magnetic force due to the sun at the earth's distance from it, in any direction, would be only a twelve-millionth of the actual force of terrestrial magnetization at any point of the earth's surface in a corresponding position relatively to the magnetic axis. Hence the sun must be a magnet[1] of not much short of 12,000 times the average intensity of the terrestrial magnet (a not absolutely inconceivable supposition, as we shall presently see) to produce, by direct action simply as a magnet, any disturbance of terrestrial magnetic force sensible to the instruments of our magnetic observatories.

Considering probabilities and possibilities as to the history of the earth from its beginning to the present time, I find it unimaginable but that terrestrial magnetism is due to the greatness and the rotation of the earth. If it is true that terrestrial magnetism is a necessary consequence of the magnitude and the rotation of the earth, other bodies comparable in these qualities with the earth, and comparable also with the earth in respect to material and temperature, such as Venus and Mars, must be magnets comparable in strength with the terrestrial magnet, and they must have poles similar to the earth's north and south poles on the north and south sides of their equators, because their directions of rotation, as seen from the north side of the ecliptic, are the same as that of the earth. It seems probable, also, that the sun, because of its great mass and its rotation in the same direction as the earth's rotation, is a magnet with polarities on the north and south sides of its equator, similar to the terrestrial northern and southern magnetic polarities. As the sun's equatorial surface-velocity is nearly four and a half times the earth's, it seems probable that the average solar magnetic moment exceeds the terrestrial considerably more than according to the proportion of bulk. Absolutely ignorant as we are regarding the effect of cold solid rotating bodies such as the earth, or Mars, or Venus, or of hot fluid rotating bodies such as the sun, in straining the circumambient ether, we cannot say that the sun might not be 1000, or 10,000, or 100,000 times as intense a magnet as the earth. It is, therefore, a perfectly proper object for investigation to find whether there is, or is not, any disturbance of terrestrial magnetism, such as might be produced by a constant magnet in the sun's place with its magnetic axis coincident with the sun's axis of rotation. Neglecting for the present the seven degrees of obliquity of the sun's equator, and supposing the axis to be exactly perpendicular to the ecliptic, we have an exceedingly simple case of magnetic action to be considered: a magnetic force perpendicular to the ecliptic at every part of the earth's orbit and varying inversely as the cube of the earth's distance from the sun. The components of this force parallel and perpendicular to the earth's axis are, respectively, 0·92 and 0·4 of the whole; of which the former could only be perceived in virtue of the varying distance of the earth from the sun in the course of a year; while the latter would give rise to a daily variation, the same as would be observed if the red ends of terrestrial magnetic needles were attracted towards an ideal star of declination 0° and right ascension 270°. Hence, to discover the disturbances of terrestrial magnetism, if any there are, which are due to direct action of the sun as a magnet, the photographic curves of the three magnetic elements given by each observatory should be analysed for the simple harmonic constituent of annual period and the simple harmonic constituent of period equal to the sidereal day. We thus have two very simple problems, each of which may be treated with great ease separately by a much simplified application of the principles on which Schuster has treated his much more complex subject, according to Gauss' theory as to the external or internal origin of the disturbance, and Prof. Horace Lamb's investigation of electric currents induced in the interior of a globe by a varying external magnet. The sidereal diurnal constituent which forms the subject of the second of these simplified problems is smaller, but not much smaller, than the solar diurnal term which, with the solar semi-diurnal, the solar ter-diurnal, the solar quarter-diurnal constituents form the subjects of Schuster's paper. The conclusion at which he has arrived, that the source of the disturbance is external, is surely an ample reward for the great labour he has bestowed on the investigation hitherto; and I hope he may be induced to undertake the comparatively slight extension of his work which will be required for the separate treatment of the two problems of the sidereal diurnal and the solar annual constituents, and to answer for each the question:—Is the source external or internal?

But even though external be the answer found in each case, we must not from this alone assume that the cause is direct action of the sun as a magnet. The largeness of the solar semi-diurnal, ter-diurnal, and quarter-diurnal constituents found by the harmonic analysis, none of which could be explained by the direct action of the sun as a magnet, demonstrate relatively large action of some other external influence, possibly the electric currents in our atmosphere, which Schuster suggested as a probable cause. The cause, whatever it may be, for the semi-diurnal and higher constituents would also probably have a variation in the solar diurnal period on account of the difference of temperature of night and day, and a sidereal and annual period on account of the difference of temperature between winter and summer.

Even if, what does not seem very probable, we are to be led by the analysis to believe that magnetic force of the sun is directly perceptible here on the earth, we are quite certain that this steady force is vastly less in amount than the abruptly varying force which, from the time of my ancestor in the Presidential Chair, Sir Edward Sabine's discovery,[1] forty years ago, of an apparent connection between sunspots and terrestrial magnetic storms, we have been almost compelled to attribute to disturbing action of some kind at the sun's surface.

As one of the first evidences of this belief, I may quote the following remarkable sentences from Lord Armstrong's Presidential Address to the British Association at Newcastle, in 1863:—

"The sympathy also which appears to exist between forces operating in the sun and magnetic forces belonging to the earth merits a continuance of that close attention which it has already received from the British Association, and of labours such as General Sabine has, with so much ability and effect, devoted to the elucidation of the subject. I may here notice that most remarkable phenomenon which was seen by independent observers at two different places, on September 1, 1859. A sudden outburst of light, far exceeding the brightness of the sun's surface, was seen to take place, and sweep like a drifting cloud over a portion of the solar face. This was attended with magnetic disturbances of unusual intensity, and with exhibitions of aurora of extraordinary brilliancy. The identical instant at which the effusion of light was observed was recorded by an abrupt and strongly-marked deflection in the self-registering instruments at Kew. The phenomenon as seen was probably only part of what actually took place, for the magnetic storm in the midst of which it occurred commenced before, and continued after the event. If conjecture be allowable in such a case, we may suppose that this remarkable event had some connection with the means by

[1] The moon's apparent diameter being always nearly the same as the sun's, the statements of the last four sentences are applicable to the moon as well as to the sun, and are important in connection with speculation as to the cause of the lunar disturbance of terrestrial magnetism, discovered nearly fifty years ago by Kreil and Sabine.

[1] Communication to the Royal Society, March 18, 1852 (*Phil. Trans.*, vol. clxii. p. 143).

which the sun's heat is renovated. It is a reasonable supposition that the sun was at that time in the act of receiving a more than usual accession of new energy; and the theory which assigns the maintenance of its power to cosmical matter, plunging into it with that prodigious velocity which gravitation would impress upon it as it approached to actual contact with the solar orb, would afford an explanation of this sudden exhibition of intensified light, in harmony with the knowledge we have now attained, that arrested motion is represented by equivalent heat."

It has certainly been a very tempting hypothesis, that quantities of meteoric matter suddenly falling into the sun is the cause, or one of the causes, of those disturbances to which magnetic storms on the earth are due. We may, indeed, knowing that meteorites do fall into the earth, assume without doubt that much more of them fall, in the same time, into the sun. Astronomical reasons, however, led me long ago to conclude that their quantity annually, or per century, or per thousand years, is much too small to supply the energy given out by the sun in heat and light radiated through space, and led me to adopt unqualifiedly Helmholtz's theory, that work done by gravitation on the shrinking mass is the true source of the sun's heat, as given out at present, and has been so for several hundred thousand years, or several million years. It is just possible, however, that the outburst of brightness described by Lord Armstrong may have been due to an extraordinarily great and sudden falling in of meteoric matter, whether direct from extra-planetary space, or from orbital circulation round the sun. But it seems to me much more probable that it was due to a refreshed brightness produced over a larger area of the surface than usual by brilliantly incandescent fluid rushing up from below, to take the place of matter falling down from the surface, in consequence of being cooled in the regular *régime* of solar radiation. It seems, indeed, very improbable that meteors fall in at any time to the sun in sufficient quantity to produce dynamical disturbances at his surface at all comparable with the gigantic storms actually produced by hot fluid rushing up from below, and spreading out over the sun's surface.

But now let us consider for a moment the work which must be done at the sun to produce a terrestrial magnetic storm. Take, for example, the magnetic storm of June 25, 1885, of which Adams gives particulars in his paper of June, 1891 (Phil. Trans., p. 139 and Pl. 9). We find at eleven places, St. Petersburg, Stonyhurst, Wilhelmshaven, Utrecht, Kew, Vienna, Lisbon, San Fernando, Colaba, Batavia, and Melbourne, the horizontal force increased largely from 2 to 2.10 p.m., and fell at all the places from 2.10 to 3 p.m., with some rough ups and downs in the interval. The storm lasted altogether from about noon to 8 p.m. At St. Petersburg, Stonyhurst, and Wilhelmshaven, the horizontal force was above par by 0·00075, 0·00088, and 0·00090 (C.G.S. in each case) at 2.10 p.m.; and below par by 0·0007, 0·00066, 0·00075 at 3 o'clock. The mean value for all the eleven places was nearly 0·0005 above par at 2h. 10m., and 0·0005 below par at 3h. The photographic curves show changes of somewhat similar amounts following one another very irregularly, but with perfectly simultaneous correspondence at the eleven different stations, through the whole eight hours of the storm. To produce such changes as these by any possible dynamical action within the sun, or in his atmosphere, the agent must have worked at something like 160 million million million million horse-power[1] (12×10^{35} ergs per sec.), which is about 364 times the total horse-power ($3 \cdot 3 \times 10^{33}$ ergs per sec.) of the solar radiation. Thus, in this eight hours of a not very severe magnetic storm, as much work must have been done by the sun in sending magnetic waves out in all directions through space as he actually does in four months of his regular heat and light. This result, it seems to me, is absolutely conclusive against the supposition that terrestrial magnetic storms are due to magnetic action of the sun; or to any kind of dynamical action taking place within the sun, or in connection with hurricanes in his atmosphere, or anywhere near the sun outside.

It seems as if we may also be forced to conclude that the supposed connection between magnetic storms and sun-spots is unreal, and that the seeming agreement between the periods has been a mere coincidence.

We are certainly far from having any reasonable explanation of any of the magnetic phenomena of the earth; whether the fact that the earth is a magnet; that its magnetism changes vastly, as it does from century to century; that it has somewhat regular and periodic annual, solar diurnal, lunar diurnal, and sidereal diurnal variations; and (as marvellous as the secular variation) that it is subject to magnetic storms. The more marvellous, and, for the present inexplicable, all these subjects are, the more exciting becomes the pursuit of investigations which must, sooner or later, reward those who persevere in the work. We have at present two good and sure connections between magnetic storms and other phenomena: the aurora above, and the earth currents below, are certainly in full working sympathy with magnetic storms. In this respect the latter part of Mr. Ellis's paper is of special interest, and it is to be hoped that the Greenwich observations of earth currents will be brought thoroughly into relation with the theory of Schuster and Lamb, extended, as indeed Professor Schuster promised to extend it, to include not merely the periodic diurnal variations, but the irregular sudden changes of magnetic force taking place within any short time of a magnetic storm.

[1] 1 horse power $= 7 \cdot 46 \times 10^9$ ergs per second.

In my Presidential address of last year I referred to the action of the International Geodetic Union, on the motion of Prof. Foerster, of Berlin, to send an astronomical expedition to Honolulu for the purpose of making a twelve months' series of observations on latitude, corresponding to twelve months' simultaneous observations to be made in European observatories; and I was enabled, through the kindness of Prof. Foerster, to announce as a preliminary result, derived from the first three months of the observations, that the latitude had increased during that time by ½ sec. at Berlin, and had decreased at Honolulu by almost exactly the same amount. The proposed year's observations, begun in Honolulu on June 1, 1891, were completed by Dr. Marcuse, and an elaborate reduction of them by the permanent Committee of the International Geodetic Union was published a month ago at Berlin. The results are in splendid agreement with those of the European observatories: Berlin, Prag, and Strasbourg. They prove beyond all question that between May 1891 and June 1892 the latitude of each of the three European observatories was a maximum, and of Honolulu a minimum, in the beginning of October, 1891: that the latitude of the European observatories was a minimum, and of Honolulu a maximum, near the beginning of May, 1892: and that the variations during the year followed somewhat approximately, simple harmonic law as if for a period of 385 days, with range of about ¼ sec. above and below the mean latitude in each case. This is just what would result from motion of the north and south polar ends of the earth's instantaneous axis of rotation, in circles on the earth's surface of 7·5 metres radius, at the rate of once round in 385 days.

Sometime previously it had been found by Mr. S. C. Chandler that the irregular variations of latitude which had been discovered in different observatories during the last fifteen years seemed to follow a period of about 427 days, instead of the 306 days given by Peters' and Maxwell's dynamical theory, on the supposition of the earth being wholly a rigid body. And now, the German observations, although not giving so long a period as Chandler's, quite confirm the result that, whatever approximation to following a period there is, in the variations of latitude, it is a period largely exceeding the old estimate of 306 days.

Newcomb, in a letter which I received from him last December, gave, what seems to me to be, undoubtedly, the true explanation of this apparent discrepance from dynamical theory, attributing it to elastic yielding of the earth as a whole. He added a suggestion, specially interesting to myself, that investigation of periodic variations of latitude may prove to be the best means of determining approximately the rigidity of the earth. As it is, we have now, for the first time, what seems to be a quite decisive demonstration of elastic yielding in the earth as a whole, under the influence of a deforming force, whether of centrifugal force round a varying axis, as in the present case, or of tide-generating influences of the sun and moon, with reference to which I first raised the question of elastic yielding of the earth's material many years ago.

The present year's great advance in geological dynamics forms the subject of a contribution by Newcomb to the Monthly Notices of the Royal Astronomical Society of last March. In a later paper, published in the *Astronomische Nachrichten*, he examines records of many observatories, both of Europe and America, from 1865 to the present time, and finds decisive evidence that from 1865 to 1890 the variations of latitude were much less than they have been during the past year, and seeming to show that an augmentation took place, somewhat suddenly, about the year 1890.

When we consider how much water falls on Europe and Asia

during a month or two of rainy season, and how many weeks or months must pass before it gets to the sea, and where it has been in the interval, and what has become of the air from which it fell, we need not wonder that the distance of the earth's axis of equilibrium of centrifugal force from the instantaneous axis of rotation should often vary[1] by five or ten metres in the course of a few weeks or months. We can scarcely expect, indeed, that the variation found by the International Geodetic Union during the year beginning June, 1891, should recur periodically for even as much as one or two or three times of the seeming period of 385 days.

One of the most important scientific events of the past year has been Barnard's discovery, on September 9, of a new satellite to Jupiter. On account of the extreme faintness of the object, it has not been observed anywhere except at the Lick Observatory in California. There, at an elevation of 4500 ft., with an atmosphere of great purity, and with a superb refractor of 36″ aperture, they have advantages not obtainable elsewhere. The new satellite is about 112,000 miles distant from Jupiter, and its periodic time is about 11h. 50m. Mr. Barnard concludes a short statement of his discovery with the following sentences :—"It will thus be seen that this new satellite makes two revolutions in one day, and that its periodic time about the planet is less than two hours longer than the axial rotation of Jupiter. Excepting the inner satellite of Mars, it is the most rapidly revolving satellite known. When sufficient observations have been obtained, it will afford a new and independent determination of the mass of Jupiter. Of course, from what I have said in reference to the difficulty of seeing the new satellite, it will be apparent that the most powerful telescopes of the world only will show it" (dated Mount Hamilton, September 21, 1892).

Sir Robert Ball, in calling my attention to it, remarks that "it is by far the most striking addition to the solar system since the discovery of the satellites to Mars in 1877." To all of us it is most interesting that during this year, when we are all sympathizing with the University of Padua in its celebration of the third centenary of its acquisition of Galileo as a professor, we have first gained the knowledge of a fifth satellite in addition to the four discovered by Galileo.

Rudolph Virchow (COPLEY MEDAL).

Professor Virchow's eminent services to science are known throughout the world, and they are far too varied and numerous for enumeration.

He survives Schwann, Henle, and the other pioneers in several branches of natural history who came from the school of Johannes Müller, and at the present time occupies a position of influence and honour equal to that of his great contemporaries Helmholtz, Ludwig, and Du Bois-Reymond.

His contributions to the study of morbid anatomy have thrown light upon the diseases of every part of the body,[2] but the broad and philosophical view he has taken of the processes of pathology has done more than his most brilliant observations to make the science of disease.

In histology he has the chief merit of the classification into epithelial organs, connective tissues, and the higher and more specialized muscle and nerve. He also demonstrated the presence of neuroglia in the brain and spinal cord, and discovered crystalline hæmatoidine, and the true structure of the umbilical cord.

In pathology, strictly so called, his two great achievements—the detection of the cellular activity which lies at the bottom of all morbid as well as normal physiological processes, and the classification of the important group of new growths on a natural histological basis—have each of them not only made an epoch in medicine, but have been the occasion of fresh extension of science by other labourers.

In ethnological and archæological science Professor Virchow has made observations which only the greatness of his other work has thrown into the shade; and, so far from confining himself to technical labours, he has been known since he migrated to Würzburg and returned to Berlin as a public-spirited, far-seeing, and enlightened politician.[3]

[1] See Brit. Assoc. Reports, 1876, Address to Section A, pp. 10–11.

[2] Among these may be mentioned his discovery of lucæmia, of lardaceous degeneration, and glioma; his reconstruction of the kind of tumour known as sarcoma, and his establishment of the important group of granulomata.

[3] A short pamphlet, "Ueber die Nationelle Bedeutung der Naturwissenschaften," may be mentioned as characteristic of the patriotism, the fairness and the broad judgment of the author.

Universally honoured and personally esteemed by most of the leading pathologists in this country, as well as on the Continent and in America, who had the good fortune to be his pupils, Prof. Virchow is a worthy successor of the many illustrious men of science to whom the Copley medal has been awarded.

Nils C. Dunér, Director of the Observatory of Lund (RUMFORD MEDAL).

Dr. Dunér has been continuously at work, since 1871, at astronomical observations (see "R.S. Catalogue").

He began to turn his attention to spectroscopic subjects in 1878, and commenced the publication of his systematic work on Stellar Spectra in 1882.

In 1884 he brought to a conclusion his wonderful observations of stars of Vogel's III Class. His memoir contains a detailed study of the spectra of nearly 400 stars, all which are the most difficult objects to observe. This volume is one of the foundations on which any future work in this direction must be based.

In 1891 he published another series of researches on the rotation of the sun, comparing true solar with telluric lines for regions up to 75° of solar latitude. The result showed a diminution of angular velocity with increasing latitude, thus spectroscopically confirming Carrington's results.

Professor Charles Pritchard, D.D., F.R.S., Director of the Oxford University Observatory (ROYAL MEDAL).

Professor Pritchard began his publications on astronomical subjects in 1852. His first paper and several others which have followed, have dwelt with the construction of object glasses and telescope adjustments.

He was president of the Royal Astronomical Society in the years 1867 and 1868.

He was appointed first Director of the newly-founded observatory at Oxford in 1874. It is now the most active University observatory in the kingdom, as many as fifteen students receiving instruction in observatory work at times. The services he has rendered to astronomy in devising, and keeping at a high standard, the work of the observatory in many directions, including its use as a school, are very noteworthy.

Immediately on the establishment of the observatory he saw the beneficial effects of photographic investigation, and first applied the method, with the old wet-plate photography, to the problem of the physical libration of the moon. He saw that this problem was encumbered in heliometric work by the fact that a set of the observations must take a considerable time, and therefore they were made on a constantly changing disc, necessitating great labour in reduction. By the observations being made in two or three seconds, the picture of the moon did not alter in the time. The result was to show important variations from Bouvard's work, which variations in their important particulars were confirmed by Dr. Hartwig.

Next (1885) the relative motions of the Pleiades were taken up with a view of tracing gravitational effects in the various members of the group. This question is not ripe for solving, but it induced heliometer observers to take up the question, and important progress is now being made.

The photometric work detailed in the "Uranometria Nova Oxoniensis," also published in 1885, consisted in measuring the light received from all stars visible to the naked eye, to 10° south declination, by means of a wedge photometer devised by Prof. Pritchard—a form of photometer now in the hands of many astronomers. In the course of this work Prof. Pritchard, at his own expense, took an assistant to Egypt to determine the effects of atmospheric absorption in a more constant climate than that of Oxford. This photometric work has been recognized by the award of the gold medal of the Royal Astronomical Society.

Having fully determined the capacity of photography for accurate measurement, Prof. Pritchard next applied it to parallax determinations of stars of the second magnitude. Some thirty stars altogether have been investigated, and this work has just been published. Thirty is a greater number than any other astronomer has attempted.

Prof. Pritchard is now working on the International Chart of the Heavens, and taking part in researches to ensure an accurate photometric scale.

John Newport Langley, F.R.S. (ROYAL MEDAL).

Some of the most important of Mr. Langley's researches have been upon the Physiology and Histology of Secreting Glands.

Extending the observations of Kühne and Lea on the pancreas, Mr. Langley showed in an elaborate series of researches, extending over the salivary and most of the important secreting glands of the body, that the formation, as a morphological element within the secreting cell, at the expense of its protoplasm, of the material to be used in the secretion is a general function of secreting cells. The dependence of this function upon the activity of nerves, and upon other forms of excitation, such as the action of drugs, has been greatly elucidated in the course of these researches. Concurrently with the morphological changes within the cells, the chemical changes which occur within the secretion as the result of nerve activity or inactivity have been investigated, and many important facts brought to light regarding the nature of the action or modifications of the action which may be brought to bear upon the secreting cell through the nervous system. These researches are published partly in the Philosophical Transactions, and partly in a long series of articles in the *Journal of Physiology*, which have extended over several years. It is not too much to say that these researches of Mr. Langley upon secreting glands give him a claim to occupy the highest rank as a physiological investigator.

The other most important researches which Mr. Langley has published have been—(1.) Upon the central nervous system, including especially an investigation into the anatomical changes which result from central lesions; (2.) Upon the sympathetic nervous system, and particularly a number of researches, based upon physiological methods, into its peripheral distribution to involuntary muscle and glands. Mr. Langley's eminence in those branches of physiology to which he has mainly devoted his attention is universally admitted, and has been publicly recognized by his having been requested more than once by international assemblies of physiologists to investigate and report on difficult cases submitted to them (*vide* "Transactions of the International Medical Congress," 1881, and "Proceedings of the Physiological Congress at Basel," 1890).

Prof. François Marie Raoult, of Grenoble (DAVY MEDAL).

For his researches on the freezing-points of solutions and on the vapour pressures of solutions.

Sir Joseph Dalton Hooker, F.R.S. (DARWIN MEDAL).

Although the regulations relating to the award of this medal direct that it is to be treated rather as a means of encouraging young naturalists to fresh exertion than as a reward for the lifelong labours of the veteran, there would seem to be a special appropriateness in awarding it to one who was intimately associated with Mr. Darwin in the preparation of the "Origin of Species." That no one was more closely associated than Sir J. D. Hooker with Mr. Darwin in the work is abundantly proved by the following passage in the introduction to the "Origin of Species":—"I cannot, however, let this opportunity pass without expressing my deep obligations to Dr. Hooker, who, for the last fifteen years (1844–59), has aided me in every possible way by his large stores of knowledge and his excellent judgment."

NOTES.

MR. W. FLINDERS PETRIE has been appointed to the chair of Egyptology, founded at University College, London, under the will of the late Miss Amelia B. Edwards. He hopes to begin his new duties soon after Christmas, and to undertake the following work:—(1) Lectures on current discoveries, on history, and on the systematic study of Egyptian antiquities; (2) lessons on the language and philology of Egypt; (3) attendance in the library on fixed days for the assistance and direction of students working there; (4) practical training on excavations in Egypt.

THE American Philosophical Society, as we have already stated, proposes to celebrate next year the one hundred and fiftieth anniversary of its foundation. It has now been arranged that reunions will be held at the Hall of the Society in Philadelphia from May 22 to 26, 1893, "at which papers may be offered by title by such delegates as may honour the Society with their presence."

THE foundation stone of the new buildings of the Durham College of Science, Newcastle, will be laid by Lord Durham on Monday, December 5.

MR. EDGAR R. WAITE, curator to the Leeds Philosophical Society, has received from the Government of New South Wales the appointment of assistant curator in the Australian Museum at Sydney, where he will have special charge of the reptile and fish sections. The *Yorkshire Post* says that at Leeds Mr. Waite has in many ways actively identified himself with local scientific research and studies, having for some years been, in conjunction with Mr. Denison Roebuck, responsible for the secretarial work —an honorary position—of the Yorkshire Naturalists' Union, and also editor of the *Naturalist*.

ON November 1 an industrial school which seems likely to be of good service was opened at Lucknow by Sir Auckland Colvin. It is intended to provide a suitable education for children of the artizan class—an education which comprises instruction in reading and writing, arithmetic, elementary mechanics, physics, and drawing, the whole being in subordination to manual training in the workshop, under skilled instructors. Manual training will for the present be confined to carpentry, but ultimately training in iron and other metal work will be added to the curriculum. Drawing will be taught to every pupil from the outset.

VARIOUS members of the department of biology in connection with Columbia College, New York, are now delivering lectures which are addressed especially to persons who desire to keep abreast of the later advances in biology without entering any of the technical courses. The subjects of the lectures are the history of the theory of evolution; the cellular basis of heredity and development; the origin and evolution of fishes; and Amphioxus and other ancestors of the vertebrates.

THE so-called "Boxing Kangaroo" now being exhibited at the Westminster Aquarium is a fine male of *Macropus giganteus* There is, no doubt, a certain amount of humbug in attributing "boxing" qualities to this animal, but it is very interesting to find that a member of the low Mammalian order, "*Marsupialia*," can be so well trained and instructed.

THE weather during the past week has remained very dull in all parts of the country, with occasional fog in London and other places, while some heavy rain has fallen in the north and west. The anticyclone which for some time past had been situated over the eastern portion of the United Kingdom gradually dispersed, and the distribution of pressure became favourable to the passage of cyclonic disturbances across the country. Towards the close of the period an area of very high pressure formed to the southward of our islands, the barometer reading 30·5 ins. and upwards, while to the north of Scotland it was more than an inch lower. Under these conditions strong westerly winds became general, and gales were experienced on our exposed coasts. Temperature was at first mild and very uniform over the whole country, there being generally little difference between the day and night readings, while the air was very damp. On Tuesday, however, the thermometer fell several degrees, with some snow and hail in Scotland and Ireland. The *Weekly Weather Report* shows that for the period ending November 26 rainfall was deficient in all parts of the country except the south of Ireland, where more than twice the average amount fell. Bright sunshine was considerably below the mean in all districts, except in the north of Scotland, where there was 22 per cent. of the possible amount, while the Channel Islands had 16 per cent. It ranged from 3 per cent. in the south-west of England (where the amount quoted for the previous week should have been 20) and midland counties, to 1 in the east of England and less than 0·5 in the north-east of England.

ON the 18th ult. Captain H. Toynbee, late Marine Superintendent of the Meteorological Office, delivered a lecture before the Shipmasters' Society on "Weather Forecasting for the British Islands." The chief object of the lecture was to explain

how a careful observer in the British Islands may form a good judgment of the coming weather. The lecturer showed, with the aid of diagrams, the tracks followed by storm centres, with reference to the conditions of areas of low and high pressure. The reason why storms usually proceed in a north-easterly direction across or skirting these islands was explained as owing to the high barometer generally to be found in the Atlantic in the vicinity of the Azores, while in the neighbourhood of Iceland there is a region where the barometer is generally lower than in the space surrounding it. The storms generally advance so as to leave the low pressure on their left, and the high pressure on their right—moving round the south and east sides of the prevailing low pressure. Considerable stress was laid upon the importance of observing the cirrus clouds, the different motions of which, in conjunction with the indications of the barometer, are useful guides both as to the approach of a storm and the track along which the centre is moving. Several illustrations of these facts were given by the lecturer, who also gave many valuable hints as to what may be learnt from the published daily weather charts.

THE Leeds Naturalists' Club seems to be in no hurry about the publication of its Transactions, those for the year 1890 having only just been issued. The volume, however, has been prepared with great care, and shows that much good work is being done by the Club. Among the contents is a most interesting abstract of a lecture by the Rev. Edward Jones on relics found in Yorkshire caves. Reference was made to the cave at Kirkdale, near York, and the Victoria Cave of Settle, both of which have been well worked and have given valuable results; but attention was directed mainly to the cave found at Elbolton or Thorp, which is situated ten miles north of Skipton and two miles from Grassington. Through the energy of the president and members of the Skipton Natural History Society, this cave, which has been handed over to them, has been worked with great earnestness, and many bones have been turned up. Human remains, representing some thirteen bodies, have been found in an excellent state of preservation. These human beings must have been buried there, as they were all found in a sitting position, with the knees brought under the chin. The cave, however, was not used only as a burial-place, for the remains of charcoal fires, burnt bones, and pieces of pottery have been found. At the time when the lecture was delivered, the excavations had not revealed anything older than the Neolithic period. Among the finds are several specimens of bones of bears, red deer, foxes, dogs, badgers, grizzle and brown bears, &c. Some time after the delivery of the lecture the members of the Club made an excursion to this interesting cave, which was explored for a distance of a hundred feet, and to a vertical depth of thirty feet. The visitors saw many stalactites and stalagmites in course of formation, and the osseous remains of animals, including some now extinct. Mr. Jones pointed out the former location of several human skeletons.

MR. J. W. TOURNEY contributes to *Science* (November 11) an excellent paper on cliff and cave dwellings in Central Arizona. He refers especially to dwellings in cliffs rising a hundred feet or more above Beaver Creek, which flows into the Verde river. In the perpendicular walls of one of these cliffs is a well-preserved ruin known as Montezuma's castle. It is midway between the rim of the cliff and the bed of the stream, and is neither house nor cave, but a combination of the two. Not accessible from the summit of the cliff, it can only be reached from below, and even here not without the use of a ladder, which, if short, the climber must pull up from one ledge to another in making the ascent. The entire front is of artificial walls built of large, flat pieces of limestone, with openings here and there for doors and windows. The rooms are small, only about five feet to the ceiling. Generally a small opening two or three feet in diameter connects one room with another, and a small orifice in the ceiling gives access to the room above. The openings in the ceilings are never directly under one another, so that any one who might stumble could only fall the height of one story. The floors are mostly of flat stones supported on timber cut from the surrounding mountains. Many of the timbers are still sound. The rooms all show considerable skill in their construction. Those in the rear are dark, dungeon-like caves hollowed from the solid rock, and are now the abode of thousands of bats, which fly about in great numbers when disturbed by visitors. A few miles above Montezuma's castle, on the opposite bank of the creek, a conspicuous cone-like mountain rises a few hundred feet above the surrounding country. The summit is a narrow rim enclosing a crater some three hundred feet in diameter and with nearly perpendicular walls. Standing on the rim one can look down a hundred feet upon the dark-blue water of a small lake in the bosom of the mountain. The lake, a hundred yards in diameter and of unknown depth, is known as Montezuma's well. In the steep sides of the crater are a number of caves, which at one time were the abode of man. A few are natural, but the greater number are the result of human effort. The rim is crowned with the fallen walls of an ancient ruin more than a hundred feet long. Far down the mountain-side, below the level of the water in the crater, the outlet of the well flows from between an opening in the rocks. This stream is large and constant, and at present is used to irrigate a ranch in the valley below. Ages ago the builders of caves and castles utilized this same stream to irrigate portions of the neighbouring rich valley.

THE fourth volume of "Reports from the Laboratory of the Royal College of Physicians, Edinburgh," edited by J. B. Tuke and D. Noel Paton, has just been published. The work completed in the Laboratory during the past year was so large that an account of the whole of it could not be included in the present volume.

A LARGE dirigible balloon is being constructed (*La Nature* informs us) at the military balloon works at Chalais-Meudon, under the direction of Commandant Renard. It will be similar in form to the *La France* of 1884–5, but longer; measuring about 230 feet in length and 43 feet in its greatest diameter. By a new arrangement of motor it is expected to be able to make headway against air-currents not exceeding 40 feet per second (or 28 miles an hour). The motor is not fully described, but it will act either with gasoline or the gas of the balloon, giving an effective force of 45 horse-power on the shaft. The total weight of machinery, with supply of gasoline, &c., will be about 30 kilogrammes (or 66 lbs.) per horse power. Previously it has not been possible to make petroleum motors with a less weight than 150 to 200 kilogrammes per horse-power. The screw will be in front, and a large rudder behind; the former will make about 200 turns per minute. The first experiments with this balloon are to be made in the early spring.

DR. HEYDWEILER, of Würzburg, has constructed a new mirror electrometer for high potentials (*Zeitschr. für Instr.*). It is a kind of torsion-balance with bifilar suspension, the charged bodies being a sphere and a ring. The attraction between the two, when at different potentials, is zero when the sphere is at the centre of the ring, and also when it is infinitely removed. Hence at some intermediate distance it is a maximum. In the instrument as constructed there are two spheres of 2 cm. diameter attached to the ends of a conducting bar bent in the form of an S. The combination is suspended in a horizontal plane by two brass wires 0·1 mm. thick attached to the middle of the bar. Two brass rings 10 cm. across are fixed in a vertical position such that the spheres can be made to coincid

with their centres. In the zero position the spheres are at a distance of 3·1cm., this being a little less than the distance of maximum attraction. The deflections are indicated by those of a mirror carried by a thin glass rod attached to the curved arm below, and the motion is damped by a vane immersed in some vegetable oil. The tangents of the angle of deflection are proportional to the differences of potential to within 0·9 per cent., between the scale readings 0·05 and 0·4. The instrument is best adapted to potentials ranging from 6000 to 60,000 volts, but with potentials above 35,000 it is best to immerse it entirely in oil.

AN account of a series of experiments to determine the temperature of the flame of water-gas is given by Mr. E. Blass, of Essen, in *Stahl und Eisen*. The instruments employed were Wyborgh's air pyrometer, Chatelier's electric pyrometer, Hartmann and Braun's telephonic pyrometer, and others by Siemens, Seeger, and Ducretel. It was found that Chatelier's formula for the variation of the specific heat of water vapour and other gases at high temperatures was practically reliable. The temperatures of combustion were taken for various proportions of air and gas, beginning with a large excess of the latter. With 0·18 cubic metres of air to one of gas, the temperature was 425° C. Calculated according to the old formula this would have been 521. Allowing for variation of specific heat, the theoretical value becomes 409. For 0·714 of air, the temperature was 1170, for 4·18 it was 1218, for 9·79 it was 655, and for the proportion of air just sufficient for combustion the flame temperature was 1169°.

A NEW "shortened telescope," constructed by Dr. R. Steinheil, is described in the *Zeitschr. für Instr.* for November. The principle resembles that adopted by Dallmeyer and Dr. A. Steinheil in their telephotographic objectives. A negative system is introduced between the object-glass and the eye-piece, thus in creasing its equivalent focal length. If a be the focal length of the objective by itself, r its distance from the negative lens, and the magnification m times that produced without the negative lens, the total length of the tube is given by $l=r+m\ (a-r)$. In a telescope actually constructed on this system, the object-glass had a focal length of 16·2 cm. Its distance from the nearest surface of the negative lens was 12 cm., the equivalent focal length 60·8 cm., and the total length 27·8 cm. Hence the magnification was 3·75 times that obtained by using the objective alone. In this case, then, a magnification of 22 diameters was obtained with an effective aperture of 4 cm., a total length of 27·8 cm., and a one-inch eye-piece. If the same magnification and illumination had to be obtained by a long-focus objective, the length would have to be 6‿8 cm. Thus the length is reduced by more than one-half without the usual disadvantages of short telescopes and eye-pieces of high power.

ACCORDING to a writer in the *Pioneer Mail* of Allahabad, the thatch on Burmese houses gives a tempting shelter to snakes, especially during the rains, and many of the occupants of the houses would be surprised if they knew the number of snakes that share the shelter of their roof on a rainy night. One night an officer was wakened up by a noise in his room; and by the light of a lighted wick, floating in a tumbler of oil, he made out that two combatants were disputing the possession of the small space in the centre of the bedroom. The belligerents turned out to be a snake and a rat, that somehow had jostled against each other in the tiny tenement.

A VALUABLE report on the geology of north-eastern Alabama and adjacent portions o Georgia and Tennessee, by C. Willard Hayes, has been published as a Bulletin of the U.S. Geological Survey. Mr. Hayes explains that in writing the report he has tried to keep it as free as possible from technical terms, and, without sacrificing scientific accuracy, to present the facts in such a way as to make them intelligible to the largest possible number of readers in the region under consideration. Many details which would be of interest to the geologist have been purposely omitted, and only those which were considered essential are given. It is expected that the atlas sheets covering this region will shortly be published by the U.S. Geological Survey, and supply the details to those specially interested which are omitted from the report.

A SECOND edition of Prof. Oliver J. Lodge's "Modern Views of Electricity" has been published by Messrs. Macmillan and Co. A new chapter on recent progress has been added.

A VOLUME on "The Pharmacy and Poison Laws of the United Kingdom" has been issued from the office of *The Chemist and Druggist*. It contains also a brief account of the pharmacy laws in force in Australasia, Canada, and Cape Colony.

MR. CHARLES E. MUNROE, Torpedo Station, Newport, Rhode Island, U.S.A., has completed the manuscript of the second part of his index to the literature of explosives. The first part was issued in 1886. The second will be issued in pamphlet form if an adequate number of subscriptions is obtained.

MESSRS. FRIEDLÄNDER AND SON, Berlin, send us the latest of their lists of the books which they offer for sale. It is a list of works relating to ornithology.

PENTA-IODIDE and penta-bromide of cæsium, together with several other penta-halogen compounds of the metals of the alkalies containing mixed halogens, have been isolated by Messrs. Wells and Wheeler, and are described by them in the current number of the *Zeitschrift für Anorganische Chemie*. Cæsium penta-iodide, CsI_5, is obtained in an impure form when the crystals of the tri-iodide of cæsium, CsI_3, previously obtained by Prof. Wells and described in our note of February last, vol. xlv. p. 325, is treated with hot water, or when solid iodine is treated with a hot solution of cæsium iodide. Either of these processes produce it in the form of a black liquid, which solidifies in the neighbourhood of 73°. The tri-iodide of cæsium, moreover, which is only sparingly soluble in alcohol, is found to be much more readily soluble when a quantity of iodine, corresponding to two atoms for each molecule of the tri-iodide, is added. Upon cooling, crystals of the penta-iodide of cæsium are deposited. Remarkably well-formed crystals are obtained upon evaporation of a more dilute solution over oil of vitriol. The crystals are black and the faces extremely brilliant; they sometimes attain a diameter of a centimetre. They belong to the triclinic system according to Prof. Penfield, by whom they have been measured. They are at once distinguished from crystals of iodine by their form and brittleness. They melt at about 73°. When exposed to the air they lose iodine about as rapidly as crystals of free iodine. These crystals are anhydrous, and yield analytical numbers agreeing with the formula CsI_5. The penta-bromide of cæsium may be similarly obtained by agitating a concentrated solution of cæsium bromide with a large excess of bromine. When such a mixture is allowed to stand at a low temperature the excess of bromine slowly evaporates and the penta-bromide separates in the form of a dark red solid substance. Cæsium penta-bromide $CsBr_5$, is a very unstable substance, losing bromine rapidly at the ordinary temperature. Anothe interesting compound is cæsium tetrachloriodide, $CsCl_4I$, which was obtained by dissolving forty grams of cæsium chloride in mixture of six hundred cubic centimetres of water and two hundred cubic centimetres of concentrated hydrochloric acid, adding

thirty grams of iodine, and then saturating the liquid with chlorine gas. The temperature was raised slightly during the operation, and upon subsequent cooling the compound $CsCl_4I$ was deposited in the form of pale orange-coloured prismatic crystals belonging to the monoclinic system. The compound is only slightly soluble in water, but, with a little loss due to decomposition, may be recrystallized from that liquid. It is, however, quite stable in the air, and only decomposes upon heating, thereby producing the tri-halogen compound, $CsCl_2I$, fusing at 238°, the melting-point of this latter compound. A similar compound, containing rubidium instead of cæsium, $RbCl_4I$, may be obtained in like manner in large orange-coloured tabular crystals, likewise belonging to the monoclinic system, but of different habitus to the crystals of the cæsium compound. An analogous compound containing potassium, KCl_4I, was prepared so long ago as the year 1839, by Filhol. Messrs. Wells and Wheeler finally describe sodium and lithium salts of this description, both of which, however, contain water of crystallization. They are represented by the formulæ $NaCl_4I.2H_2O$ and $LiCl_4I.4H_2O$. Both crystallize well, the former in rhombic prisms; the latter, however, is so extremely deliquescent that measurements of the crystals have not been obtained.

THE additions to the Zoological Society's Gardens during the past week include two Common Marmosets (*Hapale jacchus*) from South-east Brazil, presented by Mrs. Comolli; an Otter (*Lutra vulgaris*) British, presented by Mr. Frederick Collier; a Black-backed Jackal (*Canis mesomelas*, jv.) from South Africa, presented by Miss Thornton; a Common Jackal (*Canis aureus*, ♀) from Fao, Persian Gulf, presented by Mr. W. D. Cumming, C.M.Z.S.; two Short-headed Phalangers (*Belideus breviceps*, ♂ ♀) from Australia, presented by Capt. S. M. Orr; a —— Lemur (*Lemur* ——) from Madagascar; six Crab-eating Opossums (*Didelphys caucrivorus*), four Ypecha Rails (*Aramides ypecha*) from South America, a Green-cheeked Amazon (*Chrysotis viridigenalis*) from Columbia, a Yellow-cheeked Amazon (*Chrysotis autumnalis*) from Honduras, purchased; a Nilotic Monitor (*Varanus niloticus*) from Africa, received in exchange; two Shaw's Gerbilles (*Gerbillus shawi*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET HOLMES (NOVEMBER 6, 1892).—The elements and ephemeris of this comet have been the subject of much computation during the present month. The first result obtained gave a place resembling in many particulars that of the long-sought-for Biela comet; but owing to an error in one of the observations, the corrected elements stated otherwise. The current number of *Astronomische Nachrichten* (No. 3129) gives four different systems of elements which have as yet been deduced, and it is quite worth while to produce them here, showing also the difference between the observed and reduced places for each in particular:

Elements, Berlin M.T.

	1892.	1892.	1892.	1892.
T =	Feb. 28·362	Mar. 19·630	May 6·301	June 6·841
	° ′	° ′	° ′	° ′
ω =	340 25·82	339 11·87	334 46·90	328 19·09
☊ =	329 21·15	332 7·30	339 37·87	346 23·01
i =	24 55·15	24 54·91	24 55·33	25 6·06
log q =	0·27766	0·26144	0·20868	0·14910
Mean place (O – R) $d\lambda$... ...	– 1′·04	–0′·81	–0′·47	+0′·20
Mean place (O – R) $d\beta$... ...	+0·86	+0·84	+0·58	+0·41

The latest information about the elements is that which has originated from Prof. Kreutz, who has found *elliptic* elements for the comet; he also says that the elements indicate that perturbations have taken place on account of the comet's proximity to the planet Jupiter. The elements are reduced from the three places observed on November 9, 13, and 17, and are as follows:—

Epoch 1892 Nov. 17·5 M.T. Berlin.

M =	22° 18′ 37″·1	
ω =	13 37 49·0	1892.0
☊ =	331 31 3·7	1892.0
i =	20 54 8·1	1892.0
φ =	24 39 30·7	
μ =	500″·407	
log u =	0·567123	
U =	7·09 years.	

Further observations of this comet are reported (*Comptes rendus*, No. 21). At Algiers, MM. Trépied, Rambaud, and Sy found its position on November 15, at 8h. 53m. 41s., Algiers mean time, to be: App. R.A. oh. 43m. 22·28s. App. Decl. + 37° 43′ 3″·9. The corresponding values found at Lyon by M. G. Le Cadet at 8h. 47m. 33s., Paris mean time, were: App. R.A. oh. 43m. 22·72s. App. Decl. + 37° 43′ 5″·9. The comet presented a bright nebulosity in the form of an elliptic segment with its axis directed in the position angle 150°, its length and breadth both being 10′. The northern edge appeared rounded and well defined. At the focus of the ellipse a condensation could be distinguished, about 20″ broad, with a prolongation inclined to the axis of the ellipse. An attempt at calculating the elements of the orbit has been made by M. Schulhof. The slow motion of the comet renders this task very difficult. Among the various systems of elements tentatively fixed there is only one which fairly agrees with all observations. In this the excentricity is as small as 0·355386, so that it will probably be possible to follow the comet throughout its orbit with the most powerful instruments. The other elements thus determined are: π = 0° 0′ 39″·1, ☊ = 328° 32′ 40″·7, i = 20° 26′ 46″·8, and log g = 0·360966.

At Bordeaux, M. F. Courty succeeded in photographing the brighter portions of the comet on November 13, with one hour's exposure. Another photograph, taken by MM. Paul and Prosper Henry at Paris, was presented to the Academy by M. Tisserand. It was obtained on November 14, with the chart photographic equatorial. The exposure lasted two hours. It is a very fine photograph, showing a well-defined and nearly circular contour. The nucleus is bright, excentric and lengthened out. Several stars can be seen through it. There is no tail except the lengthening of the nucleus, which does not extend beyond the limits of the nebulosity.

A BRIGHT COMET.—A telegram from Kiel states that Mr. W. R. Brooks has discovered a bright comet. As determined at Cambridge, U.S., its place was, on November 21, at 16h. 44·6m. Cambridge M.T.

R.A. 12h. 59m. 15·6s.
Decl. + 13° 50′ 27″·0
Daily motion + 1m. 32s., and + 25′ respectively.

Another telegram, also from Kiel, gives the position, as obtained at Vienna on November 24, at 15h. 49·7m. (Vienna M.T.), as

R.A. 13h. 3m. 6·4s.
Decl. + 15° 0′ 36″.

ASTRONOMICAL INSTRUMENTS UP TO DATE.—We have received a circular signed by Dr. L. Ambronn, of the Göttingen Observatory, and Herr Julius Springer, publisher in Berlin, setting forth the contents of a work which they propose to publish with regard to the general principles, constructions, and methods of using astronomical instruments in general. Such a book, of course, to be of the greatest value to science, must be completely done, but any one who is acquainted with the compiler and publisher mentioned above will be sure that each will do his share thoroughly and honestly. In constructing such a compendium of instruments as this is proposed to be, we might say it would be impossible for one man to do it alone, for the present state of the *feintechnik* has reached such a high pitch and the branches of astronomy are so numerous, that such an undertaking would simply be out of question. The object of this circular, besides stating the lines on which the work will be written, is to request the co-operation of all observatories. Astronomical science, especially the theoretical side, owes much, as we all know, to German workers, so that we can rely on a good response being given to this request. What is

asked is that descriptions, together with drawings or photographs not only of typical instruments but of the important parts of them, should be sent. Technical drawings also are requested, if obtainable, and these very probably could be obtained from the makers of the instruments in question. Of course it is not required that each observatory should send say a description, &c., of the transit instrument there in use, but it is hoped that any instrument of peculiar construction or special merit should be referred to. It is needless to add that all drawings, &c., if requested, will be returned with as little delay as possible, and the undersigners of the circular thank in advance all those who respond towards the completion of this undertaking. The address to which the drawings, &c., may be sent is as follows:—Dr. L. Ambronn, Göttingen, Kgl. Sternwarte.

MOTION OF β PERSEI.—*Astronomical Journal*, No. 277, contains a short note calling the attention of transit observers to the importance of observation of this variable, to confirm the irregularity in its proper motion. At the present time Algol and his neighbouring stars are conveniently situated, and it is hoped that the following list of stars will be added to working lists generally where their observation is not inconsistent with other work. The places are for the year 1875:—

	R.A. h.	m.	s.	Decl. °	′
γ Andromedæ	1	56	14	41	43·7
β Trianguli	2	2	7	34	23·7
θ Persei	2	35	40	48	41·9
41 Arietis	2	42	38	26	44·6
γ Persei	2	55	45	53	0·9
ϕ Persei	2	57	10	38	21·3
β Persei	3	0	2	40	28·3
α Persei	3	15	24	49	24·9
δ Persei	3	34	2	47	23·1
ν Persei	3	36	42	42	10·9
η Tauri	3	40	3	23	43·0
ζ Persei	3	46	17	31	30·6
ϵ Persei	3	49	28	39	38·8
ξ Persei	3	50	51	35	25·8

PROPER MOTIONS.—M. Deslandres, in *Comptes rendus* of November 14, communicates the recent work he has been carrying out with regard to the spectroscopic determinations of proper motions. The first part contains a description of the apparatus employed, showing how he has completely altered one instrument specially for this work. During the ten months of the year he has obtained several proofs of stars susceptible of furnishing radial velocity. The following are among some of the important methods of procedure:—(1) The luminous "faisceaux" of the star and of the source of light have the same aperture, and are thus as identical as possible, a condition necessary to the absolute measure of displacements. (2) The displacements of spectra is measured not only with the $H\gamma$ line of hydrogen, but with all the hydrogen, calcium, and iron lines. (3) The large surface of the mirror renders the possibility of measuring the velocities of 250 stars. Some of the results already obtained show that the work, when finished, will be of a very reliable and accurate kind. For instance, the velocity of Venus has been obtained instrumentally as 15 kilometers, while that calculated amounted to 13·55 k.m. The velocity of α Auriga on February 5, employing 30 lines of comparison, came out as 43·5 k.m., and the velocities of the components of β Auriga, a spectroscopic double, were obtained on the same day as − 845 k.m. and + 97 k.m.

GEOGRAPHICAL NOTES.

THE measurement of an arc of the meridian between Dunkirk and the Spanish frontier, which has recently been completed with the highest precision by the French Government, shows that the measurement by Delambre and Méchain in determining the length of the metre was 146·6 feet, or $\frac{1}{20000}$th too short. The new measurement accords very closely indeed with the value as deduced from Clarke's ellipsoid.

A NEW weekly paper devoted to African geography, under the title of Kettler's *Afrikanische Nachrichten*, was started at Weimar in July last, with the object of collecting and publishing the most recent information on all matters connected with Africa and the Africans. An ingenious feature is that of giving a sketch map of parts of Africa, with a small section of a map of some well-known part of Germany on the same scale below it, for the purpose of ready comparison of distances.

MR. AND MRS. THEODORE BENT have arranged to spend the winter in Abyssinia studying the ancient monuments of Axum. They will leave this country about the middle of December. We understand that Mr. Bent would welcome a scientific man who might wish to work at any of the natural conditions of eastern Abyssinia, and take advantage of the arrangements which have been made for the safety and comfort of the party. It would, of course, be necessary for such a companion to pay his own expenses and provide his own outfit.

A SPECIAL general meeting of the Royal Geographical Society was held on Monday afternoon to consider some alterations in the rules, recently decided on by the Council. It was agreed to raise the entrance fee to the Society from £3 to £5, and to augment the life-composition accordingly, relief being, however, granted by a diminution of the commutation fee to members of long standing. Other changes were made to bring the laws into harmony with the present practice of the Society in several minor matters. The meeting also passed a resolution associating itself with the act of the Council in no longer withholding the Fellowship of the Society from women.

MR. JOSEPH THOMSON'S JOURNEY TO LAKE BANGWEOLO.

MR. JOSEPH THOMSON read a paper on his expedition to Lake Bangweolo in 1890–91 to the Royal Geographical meeting on Monday night. The paper was not only of a thoroughly scientific character, but also a model of literary grace, Mr. Thomson having the trained eye which enables him to detect and throw into prominence the really important features. The expedition went up the Zambesi by way of the Kwakwa creek, encountering considerable hostility and obstruction from the Portuguese authorities on the way. Mr. Thomson speaks warmly of the great work done by the Scottish missionaries in the Blantyre and Nyassa districts. Under the kind but firm control of the missionaries the warlike Angoni tribes came in thousands to cultivate the fields, which formerly they visited only for plunder, and for the first time in all his African travels Mr. Thomson found a spot where the advent of the white man was an unmitigated blessing to the natives.

Barometric observations made while waiting for porters on the western coast of Lake Nyassa made the elevation of the lake 1430 feet, a somewhat lower result than was formerly arrived at. On August 23, 1890, the expedition, comprising Mr. Grant, Mr. Charles Wilson, and 153 porters, started from Kotakota and struck westward through unmapped country, a rough and sparsely wooded plateau with little running water. The route lay along a strip of debateable ground, inhabited by an excitable, warlike tribe, and raided equally by Mwasi's people from the north and Mpeseni's from the south. Great tact was required to avoid bloodshed, but the expedition passed safely. Then crossing the fine fertile plain of the Loangwa river, they passed over and climbed the steep Muchinga mountains to the high plateau beyond. So far the rocks had been metamorphic, with intruded masses of granite, overlaid in the valley by sandstones, shales, and marls. At one place great fossil-tree trunks were found. The Loangwa-Kalue plateau was magnificent country, glorious with the tints of early spring on the stunted trees which formed a scraggy forest over most of the surface. But no sign could be seen of the Lokinga mountains, nor was any word heard from the natives of that range so conspicuous on the maps; but on the watershed of the plateau, 5000 feet above the sea, rose the Vimbe hills in a series of isolated domes, perhaps rising 1000 feet higher. A new lake, thirty square miles in area, was found in a dip of the plateau, and named after the Moirs. Then troubles began. Small-pox broke out amongst the porters, and when Chitambo's was reached no trace could be found of the lake, on the margin of which it was supposed to stand. While the white members of the expedition were attending to their sick followers some of the healthy Swahilis marched to Old Chitambo's (which is not in Ilala but Kalinde), now deserted, and twenty miles distant from the present village, finding the tree under which the heart of Livingstone was buried still standing, and the inscription on it legible. In the dry season the Chambeze does not enter Lake Bangweolo at all, but flows direct across the marsh to the Luapula, but in the wet season

the whole of the great marsh to the south is flooded up to Chitambo. The level at that time was made out to be 3750 feet, about 250 feet lower than Livingstone's estimate. After a rest for recovering health the expedition followed the Luapula eastward through fertile country, and leaving it where the curve from the north occurs, struck across for the Kafue, but small-pox reappeared, the land was ravaged by half-caste Portuguese slave-raiders, Mr. Thomson himself fell ill, and the course had to be changed to the south with the hope of turning west again. But matters got worse instead of better, and after touching the borders of Manica, a return had to be made to Lake Nyassa, along the southern margin of the plateau, through deep valleys, and climbing the steep slopes of the Muchinga Mountains, here separated by the great parallel valley of the Lukosashe from the plateau. All the way the land was seen to be of immense possibilities for cultivation, but neglected, and inhabited by a wretched people governed by Mpeseni, himself the vilest of them all. Kotakota on the lake was reached again on January 4th, 1891, after a total journey of 1200 miles, which resulted in many important rectifications of position and much information as to the future possibilities of the plateaux.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. Hobson, late deputy Lowndean Professor, has been elected a representative of the Mathematical Board on the General Board of Studies.

Plans for a handsome building to serve as the Sedgwick Memorial Museum of Geology have been submitted to the Senate, the estimated cost being £26,000. Four members of the Syndicate appointed to prepare the plans dissent from the report of the majority, chiefly on the ground that the internal arrangements are unsatisfactory, and that the cost, initial and annual, of the proposed building will be excessive. The divergent views held on the subject will be discussed by the Senate on Saturday, December 3.

The Senate have agreed to confer on Sir R. S. Ball, the new Lowndean Professor, the complete degree of M.A., *honoris causa.*

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, November 11.—Mr. Walter Baily, M.A., Vice-President, in the chair.—The discussion on Mr. Williams's paper, the dimensions of physical quantities, was resumed by Dr. Burton. He remarked that the idea that so-called "specific quantities," such as specific gravity, are pure numbers was an erroneous one, and liable to lead to difficulties. The specific gravity of a substance was of the nature of density, and was only a simple number on the convention that the density of water was taken as unity. If dimensions be given to specific quantities their interpretation would, he thought, be easy when the rational dimensional formulæ were found. Referring to Prof. Fitzgerald's comments, he said, although the contention that all energy is ultimately kinetic could not be gainsaid, the distinction commonly drawn between kinetic and potential energy involved nothing contrary to this view, and was useful and convenient in many cases. As to the dimensions of μ and k he was inclined to favour Mr. Williams's views, for several considerations suggest that the two capacities of the medium are essentially different. Arguments to show that μ was probably absolutely constant in the ether, whilst k might be variable, were brought forward. Of the two systems of dimensions for μ and k suggested by Mr. Williams, that which made μ a density seemed preferable.—Prof. A. Lodge said he was greatly interested in propagating the idea that physical quantities are concrete, and therefore welcomed Mr. Williams's paper. He thought it desirable to keep some names for abstract numbers, and "specific gravity" should be one. If another name involving dimensions was required "specific weight," or "weight per unit volume," might be used. Speaking of the dimensions of the various terms of an equation he did not think it was usually recognized that in ordinary algebra or Cartesian geometry the principle of directed terms was rigidly adhered to, for if directed at all every term of such an equation was directed along the same line. In this respect ordinary algebra was more rigid than vector algebra. Even if circular functions were involved, as in polar co-ordinates, they had the effect of making the directions of the terms the same. Other instances of problems bringing out the same fact were mentioned. Mr. Boys thought Mr. Madden had been arguing in a circle when he spoke of the astronomical unit of mass, and deduced the dimensions of mass as L^3/T^2 from the equation $MLT^{-2} = M^2/L^2$, for it was quite impossible that this equation could be true unless γ, the gravitation constant, was introduced on the right-hand side. Mr. Williams's method was quite the reverse, for he maintained that unless k and μ were introduced in the dimensions of electric and magnetic quantities, their dimensional formulæ could not indicate the true nature of those quantities, and hence were open to objection. Mr. W. Baily, whilst agreeing with Mr. Williams on most essential points, thought the total omission of L from dimensional formulæ made the expressions more complicated and less symmetrical. For example, such expressions as XY/Z, X^2 and XYZ, which respectively represent undirected length, area, and volume, might with advantage be written L, L^2, and L^3 respectively. The restriction of the dimensions of μ and k to those which give interpretable dimensional formulæ for electrical and magnetic quantities seemed scarcely justified. Both the systems proposed could not be right, and he thought it would be more in accordance with our present want of knowledge, if a quantity U of unknown dimensions were introduced such that μ or $k = U^2$. density and k^{-1} or $\mu^{-1} = U^2$. rigidity. This would keep in view the fact that the absolute dimensions of quantities involving U were unknown. A list of the dimensions of the various quantities based on this arrangement was given. Mr. Swinburne, referring to the conventional nature of many units, said great differences exist between the ideas held by different persons about such units. Starting with the convention that unlike quantities could be multiplied together, he might have six ampères flowing in an electric circuit under a pressure of ten volts, and he might say he had sixty volt-ampères. The term "volt-ampère" could be regarded as indicating that the sixty was the numerical result of multiplying a number of volts by a number of ampères, or on the other hand it might be understood as a new unit, a *watt*, compounded of a volt and an ampère. Before Prof. Rücker's paper on suppressed dimensions was published, an electrician might have suggested measuring the length of a bench by sending an alternating current through it and determining its self-induction, which he regarded as a length. Prof. Rücker, however, would say that this could not give the right result, for μ must be taken into account. He was inclined to think that dimensions were liable to mislead. Referring to scientific writers as authorities, he said Maxwell had been careless in some cases, for he had sometimes given dimensional formulæ as zero, which really ought to have been $L^0 M^0 T^0$, or unity. In French text-books the errors had been corrected. Mr. Williams, in reply to Mr. Madden's remarks about self-induction being a length, pointed out that the subject might be looked at in two different ways, depending on whether one thinks of the *standard* of self-induction as the practical standard of measurement, or the *unit* of self-induction as a physical quantity. In the former case the *standard* was a length, but in the latter the *unit* was a quantity of the same *species* as self-induction, the nature of which was as yet unknown. If its dynamical nature was known, then the absolute dimensions of all other magnetic and electric quantities would also be determined. In answer to Prof. Fitzgerald's remarks he said it was hardly likely that he should be unacquainted with the common view that kinetic and potential energies were ultimately quantities of the same kind, for it was a view with which he was quite familiar. The fact that they have the same dimensions was sufficient to show their identity, and the idea that all energy is ultimately kinetic was fundamental to his paper. This, however, did not imply that electrification and magnetization are of necessity the same, and the suggestion that they may be the same was only one of several "probable suggestions," all of which were entitled to consideration. His chief reason for regarding Prof. Fitzgerald's suggestion as probably incorrect was that it led to a system of dimensional formulæ incapable of rational mechanical interpretation, and containing fractional powers of the fundamental units. Prof. Fitzgerald's system would make resistance an abstract number, and μ and k directed quantities, whereas the former was a concrete quantity and the two latter must be scalar in isotropic media. If he (Mr. Williams) had erred in treating electrification and magnetization as different phenomena he could only plead that he had

done nothing more than follow such authorities as Lord Kelvin, Dr. Lodge, and Mr. O. Heaviside in the matter.—The discussion on Mr. Sutherland's paper, on the laws of molecular force, was reopened by Prof. Perry reading a communication from the President, Prof. Fitzgerald. He objected to discontinuous theories, especially when Clausius had given a continuous formulæ much more accurate over a very long range than Mr. Sutherland's discontinuous ones. The introduction of Brownian motions without carefully estimating the rates required and energy represented, and without giving any dynamical explanation of their existence, was not satisfactory. It would, he said, be most interesting if Mr. Sutherland would calculate the law of variation of temperature with height of a column of convectionless gas, under conduction alone (for Maxwell thought the inverse fifth power law of molecular attraction was the only one that gave uniformity of temperature under these conditions), and if necessary make tests with solid bars. Referring to the statement that molecular attraction at one cm. was comparable with gravitation at the same distance, he thought Mr. Boys would question this, and he suggested an *experimentum crucis* of the inverse fourth power law. Both the inverse fourth and inverse fifth power laws, assumed symmetry which did not exist. He also took exception to other parts of the paper. Dr. Gladstone, referring to the relative dynic and refraction equivalents given in Table XXVIII. of the paper, said he thought it interesting to make a similar comparison between dynic and dispersion and magnetic rotation equivalents. The result as exhibited in a complete table showed a certain proportionality between the four columns but the differences were beyond the limits of experimental error. Mr. Sutherland, however, sometimes reckoned the dynic equivalent of hydrogen as 0·215, and at other times looked upon it as negligible. The analogies between the optical equivalents did not depend on the proportionality of the numbers so much as upon the fact that the refraction, dispersion, and magnetic rotation equivalents of a compound was the sum of the corresponding equivalents of its constituent atoms, modified to some extent by the way in which they were combined. Whilst a somewhat similar relation held true for the dynic equivalents, the effect of "double-linking" of carbon atoms, so evident in the optical properties, was scarcely perceptible. The result of calculating the constants from Ml instead of from M^2l was next discussed, the effect of which was to quite upset the proportionality before noticeable. Mr. S. H. Burbury said that on referring to the author's original paper, on which the present one was based, he found that a uniform distribution of molecules was assumed. On this supposition the demonstrations given were quite correct, and the potential was a maximum. If, however, the molecules were in motion the average potential must be less than the maximum, and the deductions in the present paper being based on wrong assumptions were liable to error. Prof. Ramsay remarked that many statements in the paper, on the subject of critical points, were very doubtful. Separate equations for the different states of matter were not satisfactory, neither was the artificial division of substance into five classes. The predicted differences in the critical points due to capillarity, had not been found to exist. Speaking of the virial equation, he said that hitherto R had been taken as constant. Considerations he had recently made led him to believe that R was not constant. The whole question should be reconsidered regarding R as a variable. Mr. Macfarlane Gray said he had been working at subjects similar to those dealt with in Mr. Sutherland's paper, but from an opposite point of view, no attraction being supposed to exist between molecules. In the theoretical treatment of steam he found that no arbitrary constants were required, for all could be determined thermo-dynamically. The calculated results were in perfect accord with M. Cailletet's exhaustive experiments except at very high pressures, and even here, the theoretical volume was the mean between those obtained experimentally by Cailletet and Battelli respectively. Prof. Herschel pointed out that Villarçeau had discussed the equation of the virial, where the chemical and mechanical energies were not supposed to balance each other. Mr. Sutherland's paper all turns on the existence of such a balance, and he (Prof. Herschel) could not understand why this balancing was necessary. The discussion was then closed, and the meeting adjourned.

Geological Society, November 9.—W. H. Hudleston, F.R.S., President, in the chair.—The following communications were read:—A sketch of the geology of the iron, gold, and copper districts of Michigan, by Prof. M. E. Wadsworth. After an enumeration of the divisions of the azoic and palæozoic systems of the upper and lower peninsulas of Michigan, the author describes the mechanically and chemically formed azoic rocks, and those produced by igneous agency, adding a table which shows his scheme of classification of rocks, and explaining it. The divisions of the azoic system are then described in order, beginning with the oldest—the cascade formation, which consists of gneissose granites or gneisses, basic eruptives and schists, jaspilites and associated iron ores, and granites. The rock of the succeeding republic formation are given as nearly as possible in the order of their ages, commencing with the oldest:—Conglomerate, breccia and conglomeratic schist, quartzite, dolomite, jaspilite and associated iron ores, argillite and schist, granite and felsite, diabase, diorite and porodite, and porphyrite. The author gives a full account of the character, composition, and mode of occurrence of jaspilite, and discusses the origin of this rock and its associated ores, which he at one time considered eruptive; but new evidence discovered by the State Survey and the United States Survey leads him to believe that he will have to abandon that view entirely. In the newest azoic formation, the Holyoke formation, the following rocks are met with:—Conglomerate, breccia and conglomeratic schist, quartzite, dolomite, argillite, greywacke and schist, granite and felsite (?), diabase, diorite, porodite, peridotite, serpentine, and melaphyre or picrite. The conglomerates of the Holyoke formation contain numerous pebbles of the jaspilites of the underlying republic formation; a description of the Holyoke rocks is given, and special points in connexion with them are discussed. The author next treats of the chemical deposits of the azoic system, gives a provisional scheme of classification of ores, and discusses the origin of ore deposits. The rocks of the palæozoic system are next described, and it is maintained that the eastern sandstone of lower silurian age underlies the copper-bearing or Keweenawan rocks. The veins and copper deposits are described in detail, and the paper concludes with some miscellaneous analyses and descriptions, as well as a list of minerals found in Michigan. After the reading of this paper, the President noted that it presented three sets of questions of much importance, viz., those bearing on the archæan rocks, the iron deposits and jaspilites, and the copper and gold deposits respectively. As regards the classification of the archæan rocks, some might wonder what the terms used by the author meant. The words laurentian and huronian used in Canada seemed not to be tolerated in Michigan. The officers of the United States Geological Survey have described all the archæan formations noticed by the author; the cascade as the fundamental complex, the republic as the lower marquette, and the Holyoke as the upper marquette. Was each State of the Union going to divide these archæan rocks after its own fashion? With regard to the iron rocks, he would observe that the author, after enumerating all the views in favour of their volcanic origin, now admitted that he was wrong, and that Irving and others were correct. The most important question was how the iron ores were really formed, and to this it was difficult to find a complete answer in the paper. Sir Archibald Geikie remarked that it was hardly possible to criticize a voluminous paper of this nature, in the reading of which much of the detailed statement of facts was necessarily omitted. One of its most interesting points related to the nature and classification of the rocks intermediate between the base of the Cambrian system and the oldest or fundamental gneisses. The plan which Prof. Wadsworth followed of adopting local names for the several subdivisions of the series in each region was no doubt in the meantime of advantage, until some method of correlation and identification from region to region could be discovered. But it unavoidably led to temporary confusion, for the same rock-group might turn out to have received many different names. He thought it would be of service if geologists could agree upon some general term which would denote the whole of the sedimentary groups or systems which intervene between the old gneisses and the *Olenellus*-zone. Various names had been proposed, such as azoic, eozoic, proterozoic, algonkian, to each of which some objection may be raised. The existence of a number of very thick systems of sedimentary deposits between the base of the Cambrian formation and the gneisses was now well established in this country and in North America. In the upper members of this series fossils had been found, and it might eventually be possible to group the rocks by means of palæontological evidence. But in the meantime it would be convenient to class them under one general name which would clearly mark them off from the true archæan gneisses, &c., below them and the palæozoic rocks

above. Dr. Hicks congratulated Prof. Wadsworth on his important communication; but he strongly objected to the application of the term Silurian, instead of Cambrian, to the lower palæozoic rocks of America. Dr. Hicks did not think that the author had proved his case with regard to the Keweenawan rocks, and he was still inclined to believe that they would prove to be, as suggested by other American geologists, of pre-Cambrian age—the apparent superposition being due to overthrust faults. The term eozoic, now that worm-tracks have been discovered in the pre-Cambrian rocks, is more correct than azoic for the sedimentary rocks of that age. Moreover, other organic remains will certainly be found, for it is inconceivable that ancestors of the forms comprising the rich fauna at the base of the Cambrian should not have been entombed in earlier rocks. Mr. H. Bauerman, considering the three hypotheses as to the origin of the iron ores—namely, dehydration of limonites in sandy beds, transformation from siderite, and the breaking-up of highly ferriferous igneous masses into quartz and hæmatite—thought that the first was the most likely, although there were certainly difficulties in connexion with it which made it desirable that the newer views upon the subject should be presented. He was therefore glad that they were likely to have a detailed exposition of the author's views in the journal. As regards the origin of the copper deposits, he believed that Dr. Wadsworth agreed with the views brought before the society several years since. In conclusion, he called attention to the gold deposits, which were of comparatively recent discovery, and interesting from the large number of minerals associated with the auriferous quartz veinstuff. Sir Lowthian Bell and Mr. Marr also spoke.—The gold quartz deposits of Pahang (Malay Peninsula), by H. M. Becher.—The Pambula gold-deposits, by F. D. Power.

Zoological Society, November 15.—Dr. A. Günther, F.R.S., Vice-President, in the chair.—The Secretary read a report on the additions that had been made to the Society's Menagerie during the month of October 1892, and called special attention to a very fine male Ostrich (*Struthio camelus*) presented by Her Majesty the Queen, and to a specimen of what appeared to be a new and undescribed Monkey of the genus *Cercopithecus*, obtained by Dr. Moloney at Chindi, on the Lower Zambesi, for which the name *Cercopithecus stairsi* was proposed. Attention was also called to the receipt of a series of specimens of mammals, birds, and reptiles, brought by Mr. Frank Finn, on his recent return from a zoological expedition to Zanzibar, and received from several correspondents of the Society at Zanzibar and Mombasa.—The Secretary exhibited (on behalf of Mr T. Ground) a specimen of the Siberian Pectoral Sandpiper (*Tringa acuminata*) killed in Norfolk.—Mr. G. A. Boulenger read a paper describing the remains of an extinct gigantic tortoise from Madagascar (*Testudo grandidieri*, Vaill.), based on specimens obtained in caves in South-west Madagascar by Mr. Last, and transmitted to the British Museum. The species was stated to be most nearly allied to *Testudo gigantea* of the Aldabra Islands.—Mr. W. Bateson and Mr. H. H. Brindley read a paper giving the statistical results of measurements of the horns of certain beetles and of the forcipes of the male earwig. It appeared that in some of these cases the males form two groups, "high" and "low"; the moderately high and the moderately low being more frequent than the mean form in the same locality. It was pointed out that this result was not consistent with the hypothesis of fortuitous variation about one mean form.—A communication was read from Mr. O. Thomas containing the description of a new monkey of the genus *Semnopithecus* from Northern Borneo, which he proposed to call *S. everetti* after Mr. A. Everett, its discoverer.—Mr. G. A. Boulenger read a description of a Blennioid fish from Kamtschatka belonging to a new generic form, and proposed to be called *Blenniophidium petropauli*. The specimen had been obtained in the harbour of Petropaulovski by Sir George Baden Powell, M.P., in September 1891.

Royal Meteorological Society, November 16.—Mr. A. Brewin, Vice-President, in the chair.—An interesting paper by Mr. J. Lovel was read on the thunderstorm, cloudburst, and flood at Langtoft, East Yorkshire, July 3, 1892. The author gives an account of the thunderstorm as experienced at Driffield on the evening of this day; the full force of the storm was, however, felt in the wold valleys, which lie to the north and north-west of Driffield, where great quantities of soil and gravel were removed from the hillsides and carried to the lower districts, doing a large amount of damage. Many houses in the lower parts of Driffield were flooded, and a bridge considerably injured. The storm was most severe in a basin of valleys close to the village of Langtoft, where three trenches, sixty-eight yards in length and of great width and depth, were scooped out of the solid rock by the force of the water from the cloudburst. From the appearance of the trenches it is probable that there were three waterspouts moving abreast simultaneously. This particular locality seems to be favourable for the formation of cloudbursts, as there are records of great floods having previously occurred at Langtoft, notably on April 10, 1657, June, 1857, and June 9, 1888. The author gives, in an appendix, a number of observations made on similar occurrences, together with particulars and opinions as to the cause of such outbursts by several eminent authorities.—Mr. W. H. Dines also read a paper, remarks on the measurement of the maximum wind pressure, and description of a new instrument for indicating and recording the maximum. For some years the author has been conducting a large number of experiments with various forms of anemometer; and in the early part of the present year recommended the adoption of the tube anemometer for general use, as it appeared to possess numerous advantages. The head is simple in construction, and so strong that it is practically indestructible by the most violent hurricane. The recording apparatus can be placed at any reasonable distance from the head, and the connecting pipes may go round several sharp corners without harm. The power is conveyed from the head without loss by friction, and hence the instrument may be made sensitive to very low velocities without impairing its ability to resist the most severe gale. In the present paper the author describes an arrangement of this form of anemometer which he has devised for indicating very light winds as well as recording the maximum wind pressure.

Linnean Society, November 17.—Prof. Stewart, President, in the chair.—The President having announced a proposal by the council to present a congratulatory address to the Rev. Leonard Blomefield (formerly Jenyns) on the occasion of the seventieth anniversary of his election as a Fellow of the Society, and in recognition of his continuous and useful labours as a zoologist, it was moved by Sir Wm. Flower and seconded by Dr. St. George Mivart, that the address be signed and forwarded as proposed. This was carried unanimously. In moving the resolution, Sir Wm. Flower took occasion to sketch the scientific career of Mr. Blomefield, who is now in his ninety-third year, and to recapitulate the works of which he is the author under his earlier and better known name of Jenyns. The address, which was beautifully illuminated on vellum, was then signed by those present.—Mr. George Murray exhibited and made remarks upon a genus of Algæ (*Halicystis*) new to Britain, the species shown being *H. ventricosa* from the West Indies, and *H. ovalis* from the Clyde Sea area.—Mr. Buxton Shillitoe exhibited an artificial cluster of the fruit of *Pyrus sorbus*, as put up for ripening by cultivators in Sussex.—A paper was then read by the Rev. Prof. Henslow on a theoretical origin of endogens through an aquatic habit based on the structure of the vegetative organs. The lecture, which was very fluently delivered, was profusely illustrated, and drew forth some interesting criticism from Prof. Boulger, Messrs. Henry Groves, H. Goss, and Patrick Geddes, to which Prof. Henslow replied.—On behalf of Mr. George Lewes, who was unable to be present, a paper was read by Mr. W. Percy Sladen on the *Buprestidæ* of Japan, upon which some criticism was offered by Mr. W. F. Kirby.

Royal Microscopical Society, November 16.—Dr. R. Braithwaite in the chair.—Mr. T. F. Smith read a note on the character of markings on the *Podura* scale.—An account of Mr. W. West's paper on the freshwater algæ of the English lake district was given by Mr. A. W. Bennett, who thought it was an exceedingly important contribution to our knowledge of the algæ of that district.—Mr. F. Chapman gave a *résumé* of Pt. 3 of his description of the foraminifera of the Gault of Folkestone.—Mr. C. Haughton Gill read a paper on a fungus internally parasitic in certain diatoms, illustrating his subject with specimens and photomicrographs. Mr. Bennett said that he had observed structures which might be of a similar character in desmids. He should like to enquire if by the term "spores" Mr. Gill did not mean zoospores? Had he observed them to be possessed of vibratile cilia? And could he form any idea as to how they came to be inside the diatoms? It was possible that they might be transmitted in some way by inheritance, and if so that might account for their great abundance in particular species. Mr. Gill said

that the question how these things got into diatoms was one still under consideration. As to the movements of the spores he was not at present perfectly certain that they moved at all more than a very short distance from the orifice of the beak, but he had not yet had time to examine them sufficiently to be able to answer the question as to whether they were ciliated. Diatoms were by no means the tightly shut-up boxes which they were supposed to be; they could not live or absorb nutriment unless there was some sort of passage, and he thought there was very likely a means of penetration all over them to admit of the diffusion of fluid throughout.—Mr. E. M. Nelson called attention to the fine adjustment of Messrs. W. Watson's Van Heurck microscope, which he said had been wrongly described as being on Zentmayer's plan; he found that Messrs. Watson's adjustment was provided with spring stops, which obviated all the evils complained of in Zentmayer's system; the adjustment-screw was also left-handed, so that the apparent and real motions were made to coincide, which was a great advantage when working with high powers.

OXFORD.

University Junior Scientific Club, November 9.—The President, Dr. J. Lorrain Smith, in the chair.—The President gave an exhibit to illustrate the relation of ventilation to respiratory products, after which he called on the Rev. F. J. Smith for his paper on the inductoscript and spark photography. The paper, which was illustrated with experiments, and a large and varied selection of lantern slides, dealt with the recent researches of the writer and others in an exhaustive manner. It was shown how impressions of coins, &c., could be taken on photographic plates and paper by means of the electric spark, and the various results produced by changes of pressure, &c., in the atmosphere. The second part of the paper dealt more with the instantaneous photography produced by the electric spark, and the exhibits included photographs of bullets and other rapidly-moving objects, which had been taken by the reader of the paper.—Mr. G. C. Bourne read a paper on Bütschli's researches on protoplasm, which was followed by an animated discussion in which Prof. Burdon-Sanderson and others took part.

CAMBRIDGE.

Philosophical Society, November 14.—Prof. T. McKenny Hughes, President, in the chair.—The President exhibited (1) a live tarantula, (2) quartz crystals of unusual form. The following communications were made:—(1) Preparations were exhibited showing the division of nuclei in the sporangium of a species of *Trichia*, one of the Myxomycetes. The nuclei divide throughout the sporangium, with clearly recognizable karyokinetic figures, immediately before the formation of the spores, by J. J. Lister. (2) On the reproduction of *Orbitolites*. Mr. H. B. Brady has described specimens of Orbitolites, which he obtained in Fiji, showing the margin of the disc crowded with young shells. Mr. Brady's material was worked at in the dry state, and it was at his suggestion that the author collected specimens preserved in spirit from the Tonga reefs. Examination of this material shows that large brood chambers are formed at the margin of the disc during the later stages of growth. These are at first lined with a thin layer of protoplasm. At a later stage the central region of the disc is found to be empty, and the whole of the protoplasm is massed in the brood chambers in the form of spores. The spores have the structure of the "primitive disc," which during the early stages of growth of the Orbitolites occupies the centre of the shells. They are liberated by absorption of the walls of the brood chambers, and each becomes the centre of a new disc, which is built up by additions of successive rings of chamberlets at the margin. The reproduction of Orbitolites therefore takes place by spore formation. The spore contains a single nucleus, lying in its "primordial chamber." After several rings of chamberlets have been added, a stage is reached at which the nucleus appears to be represented by numbers of irregular, darkly staining masses scattered through the protoplasm of the central part of the disc. In the later stages numbers of oval nuclei are found in the protoplasm, often arranged in pairs, and in favourable preparations they may be seen to be undergoing amitotic division — the fragmentation of the oosperm nucleus in certain ova, by S. J. Hickson.—On Gynodiœcism in the Labiatæ (second paper), by J. C. Willis. —The observations made in 1890–91 on *Origanum* (see *Reporter*, No. 937, June 7, 1892) were continued, chiefly on female plants. Six of these, derived from seed of the hermaphrodite plants of 1890, were observed, and their variations noted. It seems possible that some of the six, at any rate, were derived not from the normal, but from the abnormal (female) flowers of the parent. Attempts were made to determine if the occurrence of female flowers or flowers with one, two or three stamens only, on hermaphrodite plants, was due to lack of nourishment. A string was tied tightly round the main stalk of an inflorescence, about the middle, and it was found that more variations (12 : 1) occurred above than below. Analysis of the three years' observations shows that the abortion of the stamens tends to occur symmetrically rather than not, *i.e.* most commonly all four abort, and next in frequency is the abortion of the two anteriors: then of the two posteriors. These observations are still in progress, and it is hoped to publish full details in 1896 or later.

PARIS.

Academy of Sciences, November 21.—M. d'Abbadie in the chair.—Observations of the minor planets, made with the great meridian instrument of the Paris Observatory, from October 1, 1891, to June 30, 1892, by M. Tisserand.—Determination of the centre of the mean distances of the centres of curvature of the successive developments of any plane line, by M. Haton de la Goupillière.—Observations of Holmes' comet (November 6, 1892) made at the great equatorial of the Bordeaux Observatory, by M. G. Rayet.—Exploration of the higher regions of the atmosphere by means of free balloons provided with automatic recorders, by M. Gustave Hermite. Small balloons were filled with coal-gas and provided with recording barometers and minimum thermometers. The former consisted of metallic aneroid boxes on Vidi's system, recording the pressure by the motion of a smoked plate in front of a glass style. These aneroids weighed less than 100 grs. The writer hopes to reduce their weight to 10 grs. Some of the balloons were lost or destroyed, but most of them were returned, after a journey exceeding in many cases 100 km. Two successful registrations of temperature have been made so far, giving a fall of 1° C. for every 260 m. and 280 m. respectively.—Observations of Holmes' comet made at the Algiers Observatory (*equatorial coudé*), by MM. Trépied, Rambaud, and Sy.—Observations of Holmes' comet (November 6) made with the *equatorial coudé* of the Lyon Observatory, by M. G. Le Cadet.—Elliptic elements of Holmes' comet of November 6, 1892, by M. Schulhof (see our Astronomical Column).—On the calculation of inequalities of a high order. Application to the long-period lunar inequality caused by Venus, by M. Maurice Hamy.—Distribution into four groups of the first n numbers, by M. Désiré André.—On electric oscillations, by M. Pierre Janet. A gap in a circuit containing a high resistance of some 20,000 ohms is bridged by another containing a coil resistance with self-induction and a bridge resistance without. The terminals in the same gap are also connected with a condenser, and a Mouton's *disjoncteur* is introduced in the circuit, rotating at a high speed. The differences of potential between the terminals of the two resistances are measured by an auxiliary condenser and a ballistic galvanometer. It is thus possible to determine the form of the oscillations. On suddenly breaking the short circuit in the gap, it was found that the ends of the resistance without self-induction reached a constant difference of potential in a series of oscillations which were always of the same sign, whereas those of the other showed a series of positive and negative oscillations.—On some results furnished by the formation of soap bubbles by means of a resinous soap, by M. Izarn. Very thin and permanent bubbles are obtained by pounding together 10 gr. each of colophonium and potassium carbonate, adding 100 gr. of water and completely dissolving by boiling. For use, it must be diluted with four times its bulk of water.—Action of piperidine upon the haloid salts of mercury, by M. Raoul Varet.—On the exchanges of carbonic acid and oxygen between plants and the atmosphere, by M. Th. Schlœsing, jun.—A new case of living *Xiphopage*, the Orissa twins, by M. Marcel Baudouin.—Notes on the feet of batrachians and saurians, by M. A. Perrin.—On asymmetric growth in polychætous annelids, by M. de Saint Joseph.—Influence of moisture on vegetation, by M. E. Gain. Experiments with soils kept in a given state of humidity have led to the following conclusions: For each plant there exists a certain proportion of moisture most favourable to its growth. A high comparative moisture in the soil accelerates the growth, especially of the stem and leaves. The air being dry, fructification is slower with a dry than with a humid soil. Inflorescence is retarded either by dry soil or by moist air, and is hastened by the reverse con-

ditions. The most favourable conditions for exuberant growth of flowers are a moist soil and dry air, especially the latter.—Researches on the mode of production of perfume in flowers, by M. E. Mesnard. By the action of pure hydrochloric acid on sections immersed in strongly-sweetened glycerine, the essential oils are easily separated. It is found that the oil is generally located in the epidermic cellules of the upper surfaces of the petals or sepals. In every case the oils appear to have been derived from chlorophyll. The perfume is not given off until the oil is sufficiently freed from the intermediate products, and it exhibits some inverse relation to the amount of tannin and pigment produced in the flower.—On the existence of a conidian apparatus in the *Uredinei*, by M. Paul Vuillemin.—On the presence of *Actinocamax* in the Pyrenæan chalk, by MM. Roussel and de Grossouvre.—Stratigraphic consequences of the preceding communication, by M. A. de Grossouvre.—On the formation of the Arve valley, by M. Emile Haug.—On an experiment which appears to produce an artificial imitation of the doubling of the canals of Mars, by M. Stanislas Meunier.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, DECEMBER 1.

LINNEAN SOCIETY, at 8.—Notes on Œcodoma cephalotes and the Fungi it Cultivates: J. H. Hart.—On a Small Collection of Crinoids from the Sahul Bank, North Australia: Prof. F. Jeffrey Bell.—Descriptions of Twenty-six New Species of Land Shells from Borneo: E. A. Smith.

CHEMICAL SOCIETY, at 8.—On the Formation of Orcinol and other Condensation Products from Dehydracetic Acid: J. Norman Collie.—Isolation of Two Predicted Hydrates of Nitric Acid: S. U. Pickering.—Anhydrous Oxalic Acid: W. W. Fisher.—Observations on the Origin of Colour and of Fluorescence: W. N. Hartley.—The Origin of Colour—Azobenzene: H. E. Armstrong.—The Reduction Products of $\alpha\alpha'$ dimethyl $\alpha\alpha'$ diacetylpentane: Dr. Kipping.—The Products of the Action of Sulphuric Acid on Camphor: Drs. Armstrong and Kipping.—Methods for Showing the Spectra of easily Volatile Metals and their Salts, and of Separating their Spectra from those of the Alkaline Earths: W. N. Hartley.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Experimental Researches on Alternate Current Transformers: Prof. J. A. Fleming, F.R.S. (Discussion.)

LONDON INSTITUTION, at 6.—Photographs of Flying Bullets, &c. (Illustrated): Prof. C. V. Boys, F.R.S.

SUNDAY, DECEMBER 4.

SUNDAY LECTURE SOCIETY, at 4.—Bacteria and Infectious Diseases (with Oxy-hydrogen Lantern Illustrations): Dr. E. E. Klein, F.R.S.

MONDAY, DECEMBER 5.

SOCIETY OF ARTS, at 8.—The Generation of Light from Coal Gas: Prof. Vivian B. Lewes.

VICTORIA INSTITUTE, at 8.—Principles of Rank among Animals: Prof. Parker.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—A New Form of Filter Press for Laboratory Use: C. C. Hutchinson.—The Production of Acetic Acid from the Carbohydrates: Messrs. Cross and Bevan.—Electrolytic Soda and Chlorine; the Present Aspects of the Question: Messrs. Cross and Bevan.

LONDON INSTITUTION, at 5.—Reading as a Recreation: Edmund Gosse.

ROYAL INSTITUTION, at 5.—General Monthly Meeting.

ARISTOTELIAN SOCIETY, at 8.—Symposium—Does Law in Nature exclude the Possibility of Miracle? R. J. Ryle, Rev. C. J. Shebbeare, A. F. Shand.

TUESDAY, DECEMBER 6.

ZOOLOGICAL SOCIETY, at 8.30.—A Revision of the Genera of the Alcyonaria Stolonifera, with Descriptions of One New Genus and several New Species: Sydney J. Hickson.—Upon the Convolutions of the Cerebral Hemispheres in Certain Rodents: F. E. Beddard, F.R.S.—On a New Monkey from South-East Sumatra: Prof. Collett.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Monthly Ballot for Members.—The Manufacture of Small Arms: John Rigby. (Discussion.)

WEDNESDAY, DECEMBER 7.

GEOLOGICAL SOCIETY, at 8.—Note on the Nufenen-stock (Lepontine Alps): Prof. T. G. Bonney, F.R.S.—On some Schistose "Greenstones" and Allied Hornblendic Schists from the Pennine Alps, as Illustrative of the Effects of Pressure-Metamorphism: Prof. T. G. Bonney, F.R.S.—On a Secondary Development of Biotite and of Hornblende in Crystalline Schists from the Binnenthal: Prof. T. G. Bonney, F.R.S.—Geological Notes on the Bridgewater District in Eastern Ontario: J. H. Collins.

SOCIETY OF ARTS, at 8.—The Chicago Exhibition, 1893: James Dredge.

ENTOMOLOGICAL SOCIETY, at 7.—Further Observations upon Lepidoptera (Illustrated by the Oxy-hydrogen Lantern): Edward B. Poulton, F.R.S.—The Effects of Temperature on the Colouring of Pieris napi, Vanessa atalanta, Chrysophanus phlœas, and Tephrosia punctulata: Frederic Merrifield.—Notes on Hydroptilidæ belonging to the European Fauna, with Descriptions of New Species; Kenneth J. Morton. (Communicated by Robert McLachlan, F.R.S.)—On some Neglected Points in the Structure of the Pupa of Heterocerous Lepidoptera, and their Probable Value in Classification; with some Associated Observations on Larval Prolegs: Dr. Thomas Algernon Chapman.—Description of a New Species of Butterfly, of the Genus Calinaga, from Siam; James Cosmo Melvill.

THURSDAY, DECEMBER 8.

ROYAL SOCIETY, at 4.30.—On the Photographic Spectra of some of the Brighter Stars: Prof. J. Norman Lockyer, F.R.S.—Experiments in Examination of the Peripheral Distribution of the Fibres of the Posterior Roots of some Spinal Nerves: Dr. Sherrington.—Preliminary Account of the Nephridia and Body Cavity of the Larva of Palæmonetes varians: Edgar J. Allen.

MATHEMATICAL SOCIETY, at 8.—Note on Cauchy's Condensation Test for the Convergency of Series: Prof. M. J. M. Hill.—Additional Note on Secondary Tucker Circles: J. Griffiths.—Notes on Determinants: J. E. Campbell.—A Geometrical Note; R. Tucker.

LONDON INSTITUTION, at 7. A Plea for Catholicity of Taste in Music (Illustrated): Sir Joseph Barnby.

SATURDAY, DECEMBER 10.

INSTITUTION OF CIVIL ENGINEERS, 2 to 4.—Students' Visit to the Machinery and Inventions Division, South Kensington Museum.

BOOKS, PAMPHLETS, and SERIALS RECEIVED

BOOKS.—Berzelius und Liebig, Briefwechsel 1831–1845 (München, Lehmann).—A Short Manual of Orthopœdy, Part I.: H. Bigg (Churchill).—Congrès International de Zoologie, Deux Session à Moscou: Première Partie (Moscou).—Congrès International d'Archéologie. 11-ème Session à Moscou, vol. 1 (Moscou).—A Catalogue of British Jurassic Gasteropoda: W. H. Hudleston and E. Wilson (Dulau).—Annuaire de l'Observatoire Municipal de Montsouris, 1892–93 (Paris, Gauthier-Villars).—Les Textiles Végétaux: H. Lecomte (Paris. Gauthier-Villars).—Essais d'Or et d'Argent: H. Gautier (Paris, Gauthier-Villars).—Past and Future: C. M. Jessop (K. Paul).—Toothed Gearing: A Foreman Pattern Maker (C. Lockwood).—Modern Views of Electricity, 2nd edition: Prof. O. J. Lodge (Macmillan).—The Universal Atlas, Part 21 (Cassell).—Grasses of the Pacific Slope, Part 1: Dr. G. Vasey (Washington).—Das Keimplasma, Eine Theorie des Vererbung: Prof. A. Weismann (Jena, Fischer).—Die Zelle und die Gewebe: Prof. O. Hertwig (Jena, Fischer).—Extinct Monsters: Rev. H. N. Hutchinson (Chapman and Hall).—The Algebra of Coplanar Vectors and Trigonometry: R. B. Hayward (Macmillan).—Science in Arcady; Grant Allen (Lawrence and Bullen).—The Chemical Basis of the Animal Body: Dr. A. Sheridan Lea (Macmillan).

PAMPHLETS.—Quelle est la Race la plus Ancienne de la Russie Centrale: A. Bogdanow (Moscou).—Descriptive Notes on certain Implements, Weapons, &c., from Graham Island, Queen Charlotte Islands, &c.: A. Mackenzie.—Notes on the Shuswap People of British Columbia: G. M. Dawson.—Some Laws of Heredity and their Application to Man: S. S. Buckman (Gloucester).—Sur la Constitution des Dépôts Quaternaires en Russie et leur relations au Trouvilles Résultant de l'Activité de l'Homme Prehistorique: S. Nikitin (Moscou).—Ueber die Entwicklung von Milz und Pankreas: Dr. C. von Kupffer (München).—Verg.-Anatomische Studien über die Nerven des Armes und der Hand: Dr. W. Höfer (München).—Die Lendennerven der Affen und des Menschen: Dr. A. Uischneider (München).—Ueber das Vorkommen Offener Schlundspalten: Dr. E. Tettenhamer (München).

SERIALS.—Mittn. der Deutschen Gesellschaft für Natur und Völkerkunde Ostasiens in Tokio, 50 Heft (Tokio).—Traité Encyc. de Photographie, Premier Supplément: *A cinquième fascicule*, C. Fabre (Paris, Gauthier-Villars).—Natural Science, Decr. (Macmillan).—A Monograph of Oriental Cicadidæ, Part 7: W. L. Distant (London).

CONTENTS.

THURSDAY, DECEMBER 8, 1892.

THE NEW UNIVERSITY QUESTION.

THE correspondence between Prof. Huxley and Prof. Pearson which has appeared in the *Times* is not pleasant reading. With infinite pains and trouble an Association had been formed to support the foundation in London of a university of a certain type. A nucleus of the most eminent teachers or ex-teachers in London had collected around them a powerful body of supporters from the provinces. In Prof. Huxley as President, and Sir Henry Roscoe as Vice-President, the Association secured the services of two men distinguished both as professors and for their knowledge of affairs. It appears to have been less fortunate in its secretary. Prof. Karl Pearson had some difference with his fellow committee-men on a question of procedure. He himself has described the divergence as not fundamental and has publicly stated that he believes that the other members of the committee were aiming at securing the establishment of a university of the type which he himself approves. So comparatively trifling was the issue, that, according to Prof. Huxley, Prof. Pearson himself proposed that the reason to be given for his resignation should be "pressure of work." No doubt can therefore exist as to the cogency of this motive. His position was apparently even more clearly defined by his not voting against the course of action proposed on the occasion of a meeting which was shortly to take place between the Senate of the University of London and the Committee of the Association, and by his spontaneously pledging himself "to say nothing as a member of the deputation, contrary to what was then agreed to."

It is therefore no wonder that Prof. Huxley was surprised, when on the very next day Prof. Pearson wrote to the *Times*, discussing resolutions which Prof. Huxley regarded as confidential and accusing his colleagues of various offences, of which the day before he thought so little that he had voluntarily stated that "pressure of work" was the reason to be given for his resignation.

One good result may perhaps follow from Prof. Pearson's action. Owing to the sense which has unfortunately been attached to the word "absorb," and to the assumption that the title "Professorial University" meant a University governed solely by Professors, an opinion has got about that the members of the Association are impracticable persons, who have propounded an unworkable scheme. It is true that both accusations are directly met by the published programme of the Association. It is there made clear that a voluntary absorption is all that is aimed at, and that laymen as well as experts are to have a share in the management of the University. Prof. Pearson's defection has made it still more obvious that the Association scheme is intended, not to gratify theorists, but to support a policy which is capable of realization.

Prof. Pearson declares that he desires a University on the model of Berlin; but the question at once arises, Is the model to be followed exactly, or are modifications to be introduced? Is the University to be free from all State control? Prof. Huxley desires that it shall be free, and under existing circumstances we cordially agree with him. Let the State, if it will, nay as it must, support and subsidize the new University as it supports the British Museum, but let the control of the one, as of the other, be in the hands of an independent Governing Body. But, if this condition is realized, there is at once a fundamental difference between the actual University of Berlin and the possible University of London. The external element furnished in Germany by State control must in England be supplied by lay members of the Governing Body, and the difference thus established will run throughout the whole of the constitution.

Prof. Huxley publishes in his letter to the *Times* an outline of a scheme for the organization of the University which is too interesting to be omitted here. He explains that he gives the rough notes on which his evidence before the Gresham University Commission was based.

The scheme is as follows:—

"Do not venture to ask for all I want, but for as much as it seems possible to get on the way to that.

"Suggestions tentative and open to modification.

"(*a*) Retain title and prestige of University of London; reorganize it in such a manner as to secure general uniformity and efficiency of work with freedom and elasticity. In short, unify without fettering.

"(*b*) Make the institutions which contain technical schools of theology, law, medicine, engineering, and so on into colleges of the University. Let these examine their own candidates for degrees, under conditions determined jointly by them and the Senate of the University; and present such as they declare fit to the University for *ad eundem* graduation.

"(*c*) Deal in the same way with institutions giving adequate instruction in the other categories of University work—if they so please; or let the University examine.

"(*d*) Provide ample means for instruction in the modes of advancing natural knowledge and art, either in material connexion with the existing University or in particular colleges.

"(*e*) Professoriate to have large but not preponderant representation in Senate, and wide, but not exclusive, influence in regulating instruction and examination in accordance with the general aim at unification.

"(*f*) All state and municipal contributions, private endowments and University fees for instruction and examination to be paid into a University chest. All professorial staff and current expenses (save in cases that may be reserved) to be paid out of the University chest; also building and fitting expenses where there is no sufficient endowment of a college. The payment of the professorial staff to be primarily regulated by the kind and amount of the work done for the University, not by number of students.

"(*g*) No bar to be placed in the way of any one who desires to profit by any description of University instruction. If, after trial, he does not profit, time enough to exclude. Value of exclusion as disciplinary measure."

Any one who takes the trouble to compare this scheme with the original programme of the Association will see that they are in close accord. It is true that the Association put forward the complete voluntary absorption of the colleges as the result most to be desired, but it distinctly contemplated the possibility of relations between the University and institutions or colleges which were not completely absorbed, and it will be seen that the only terms on which Prof. Huxley will permit relations to be established between the University and the colleges secure to the former a very large measure of authority.

Prof. Huxley himself describes his scheme as of a tentative character, but whatever plan be finally adopted it is desirable that the real aims and objects of the Association shall be fully understood.

It is desired that there shall be one University in London which shall be a central authority to organize and improve higher education.

No reasonable person has ever supposed that the existing University of London was to be destroyed as a sort of peace-offering to its critics, or that existing colleges were to be ignored or dragooned into self-effacement. What is desired is that the Senate of the existing University should be reconstituted by the addition of professors teaching under the control of the University and by a reduction in the number of its lay members, if, with the new additions, it would otherwise be of unwieldy size.

It is desired that a share in the benefits to be obtained from the University should be given to any college only in so far as it is willing to put into the hands of the University the appointment and control of those of its chairs which might be recognized by the University. It is hoped that the advantages which would accrue from this partial fusion would be so great as to lead to the gradual voluntary "absorption" of the colleges. To make this desirable end attainable it is necessary that the College Councils should not be represented, as such, on the Governing Body of the University, but no objection would, we believe, be felt to temporary arrangements which might facilitate the inauguration of the new state of things.

The sooner it is clearly understood that the Association is the result of the labours and the exponent of the views of the "practical men" who are, according to Prof. Huxley, to be found in the professorial ranks, the better it will be for the Association and for London. Prof. Pearson's withdrawal from the secretaryship appears, under all the circumstances, to afford a sufficient guarantee of this.

IN SAVAGE ISLES AND SETTLED LANDS.

In Savage Isles and Settled Lands: Malaysia, Australasia, and Polynesia, 1888–1891. By B. F. S. Baden-Powell, Lieut. Scots Guards, F.R.G.S. (London: Richard Bentley and Son, 1892.)

THIS book contains the impressions of Lieut. Baden-Powell during a journey round the world of over three years' duration; jottings limited chiefly to his own personal doings and observations. The journey was evidently a leisurely peregrination with many divergences to places of interest off his direct route out to Brisbane in Queensland, whither he was bound to assume official duty on the staff of the governor of that colony, and an equally unhurried saunter home again through the Pacific and America. The author does not propose to look at things with scientific eyes, and it is possible here and there throughout the book to detect that he has no profound acquaintance with the *ologies*. Consequently his book does not fall to be rigidly criticized in these pages. His eyes, however, if not scientific, were kept at all events very wide open, and what came under his own observation is clearly and accurately described in a chatty and pleasant style and with a good deal of quiet humour. It is easy to see that the "tramp" enjoyed his trip, and the reader, drawn on by his cicerone's mood, accompanies him through savage isles and settled lands with equal satisfaction. Lieut. Baden-Powell started off through the European continent *viâ* Cologne and Vienna to Rustchuk, thence across Bulgaria, through which "a railway journey is not very interesting." Nevertheless, "little picturesque villages are seen nestling in the valleys, and distant glimpses of the Balkans gained." Beyond Shumla we get through the mountains and "pass through miles of swamp, the railway almost level with the water, and reeds growing up all around, in some places so high as to cut out all view from the carriage windows. Passing along the edges of large lakes, the train starts up thousands of wild fowl, which fly around till the air is quite darkened by them, and on we go, mile after mile, with more and more duck rising from the water," evidently a sportsman's paradise. Thence our guide conducts us to Constantinople and on to Egypt, and though he takes us by well-trodden paths and tells us little that is new or wonderful, he enlivens the way with a constant flow of time-beguiling talk and anecdote. From Egypt Mr. Baden-Powell sets out for southern Australia, but he wanders as usual off his main road for some weeks into Ceylon and India to luxuriate amid their tropic scenery and ancient monuments. Of the three southern colonies of the Australias traversed on his way to Queensland he gives us a few brief notes. Of the latter colony, where he spent some years in the enjoyable and not very arduous duties of A.D.C. to Sir Anthony Musgrave and Sir Henry Norman, he has a great deal that is interesting to tell. He visited much of the country, and saw something of its aboriginal as well as of its adopted natives, and found interest and amusement in both. At a vice-regal ball at Hughenden, a town 240 miles inland, he finds himself a fellow-guest with the butler of the hotel he was staying at, and his host's housemaid, "who was quite the belle of the ball, and who, when supper was served, turned waitress again. Such is society in a Bush town." "It was in this district," he continues, "that I first set eyes on some real wild blacks. The aboriginals of Australia are an extraordinary people. To look at they are quite unlike any other human beings I ever saw. A thick tangled mass of black hair crowns their heads; their features are of the coarsest; very large broad and flattened noses; small, sharp, bead-like eyes and heavy eyebrows. They generally have a coarse tangled bit of beard; skin very dark and limbs extraordinarily attenuated like mere bones. But they always carry themselves very erect. . . . They wander about stark naked over the less settled districts, and live entirely on what they can pick up. . . . If not the lowest type of humanity they would be hard to beat. They show but few signs of human instinct, and in their ways seem to be really more like beasts." Mr. Baden-Powell thus summarizes his opinions on Australia as a field for emigration (and those who know the Australasian colonies will recognize their truth): "The labouring man will find it a paradise; the professional man will find his profession overstocked; and the man with money to invest will probably be ruined. . . . My personal advice to would-

be emigrants except of the lowest [? lower] class is like *Punch's*—Don't."

From Queensland it was easy and natural for our traveller to be attracted across to New Guinea, the land of so much myth and mystery. Here he fell in with the indefatigable administrator, Sir W. Macgregor, and was able to lend him a helping hand in the skirmishing incident on the capture of the natives of some villages guilty of the murder of several Europeans. He spent some days at Samarai, the head-quarters of the south-eastern district; and we feel sure that the almost unsurpassable panorama visible from its hill-set bungalow of "mountains wooded to the peak," and green isles, spread out on every side, basking in an azure sea, and picturesquely veiled in haze as they lessen away to beyond the horizon, must have rewarded him for his visit, even at the expense of a bout of fever. His account of what he saw and did in Papua occupies some eighty pages, and contains more trustworthy and interesting information than many of the narratives of men who have spent a much longer time in the country than Mr. Baden-Powell did. The next region he visited was the Malay Archipelago. He only gazed on Sumatra, "that extraordinary island which contains probably a greater variety of big game, of useful plants, and of wonderful scenery than any other country of its size"; but he visited many of the most interesting places in Java, and the Straits Settlements, and made extensive journeys in Borneo, where he shot some of "the very extraordinary-looking proboscis-monkeys (*Larvatus nasalis*) . . . I should imagine," he remarks, "his ponderous nose would get very much in the way of his biting any one, and he certainly has no other means of defence." Our space will not permit us to follow Mr. Baden-Powell through New Zealand and the various islands of the Pacific sojourned in by him, except to note his account of the preparation of "king's cava," of which he was a witness, in Samoa:—

"This was a great event. None of the Consuls even had ever before partaken of 'king's cava.' But there was a certain amount of sham about it. First, the root was produced—genuine enough, I dare say. Six men then sat in a row outside the house, the nine-legged cava bowl before them. Each man was then given some water to wash his mouth out, and a packet of cava wrapped in a bit of leaf was given to each. I shuddered at the awful thought of what was about to happen. In true native fashion these nasty old men were undoubtedly going to chew the root, and I . . . would have to swallow the nauseous stuff! I watched very carefully and was much relieved when I saw the packets collected again and put in the bowl. It was ready prepared [outside in a less orthodox and less disquieting fashion] and the little ceremony was only to represent formally the mode in which it ought to be done, the cava being 'taken as chewed.' Then the bowl was solemnly brought into the house and put on the floor at the end opposite the king."

This is an interesting instance of the evolution of what might have been as meaningless a ceremonial as are many of those survivals of abandoned customs which are familiar to us in many other parts of the world.

From Samoa Lieut. Baden-Powell made his way home by the usual route *viâ* the Sandwich Islands and through the States.

"In Savage Isles and Settled Lands" is a book we can heartily recommend. It is elegantly got up, is illustrated by excellent wood engravings, and has a map of the author's route. Nearly every page presents in a few words some bright vignette that will please and inform those who have never had the opportunity of visiting those lands and isles, and will set the home-come traveller a-dreaming with grateful satisfaction of delightful days that are past, and help him to live them over again more delightfully still in the present. H. O. F.

PROPERTY.

Property: Its Origin and Development. By Chas. Letourneau, General Secretary to the Anthropological Society of Paris, and Professor in the School of Anthropology. (Walter Scott, 1892.)

LESS than a generation ago the history of early civilization was summed up, if not in the three words hunting, pasture, and agriculture, at least in the formula of Sir Henry Maine: "Society develops from family to tribe, and from tribe to State." Recent inquiries have discredited both of these formulas, and taken us back to the genesis of the family itself, and beyond civilization to barbarism and savagery. If we listen to Prof. Letourneau (to say nothing of Morgan and Maclennan), we may reconstruct the evolution of society in all its stages out of savagery by the "ethnographic method,"—"looking upon existing inferior races as living representatives of our primitive ancestors" (Preface, page ix). It must be remembered that in using this ethnographic method we assume that the order of progress has been substantially identical in all cases, and also that the simplest forms come first in time (p. 70, cf. 126). Both assumptions would need justification before the results of the new method could be finally accepted.

Prof. Letourneau had applied the method with great learning and ingenuity in his earlier book on the evolution of marriage. In the volume before us he applies it to property. He begins with a chapter on property amongst animals; ants and bees, as we might expect, are shown to be more highly developed in this matter than many men, and they have many of the vices of men. They provide for the future. Their property is that of a community; but one community wars on another for pillage. There are not only parasites, but idle aristocrats among them. The amazon ants, who cannot even feed themselves, but depend on their black slaves, are well known from Huber's description, and are a standing refutation of Solomon's high opinion of ants. On the whole, among animals, property is due simply to the instinct of self-preservation; and Letourneau ascribes it to the same origin in the case of men. Among the "anarchic hordes," which come first in his series (p. 23), and of which the Fuegians are a specimen, there is collective property. If union is strength it is weakness that first leads to union (cf. p. 368). But there is no personal property except in tools and weapons, "the immediate result of personal labour" (p. 39). Provision for the future is unknown. In the second stage (among the "republican tribes") the union is more highly organized; there is tribal government, with minute regulation of conduct in regard to the dealings of individuals with the necessaries of life. The most remarkable example is perhaps that of the people of Paraguay

among whom (as our author shows) the Jesuit missionaries found and did not make a system of communism (pp. 42 seq.). In nearly all the instances of this class the sense of property was most strongly developed in regard to the hunting ground of the tribe, though (in the case of the Iroquois, &c.) it embraced the Long Houses of the clans of the tribe, an anticipation of Fourier's phalansteries. The differentiation of the clan from the tribe is ascribed to the growth of the taste for property itself (cf. p. 365). Letourneau would explain the present universality of human sympathy as a bequest to us from the days when all property was common (p. 57). The republican organization passed into the monarchical, where the tribe was governed by its chief (pp. 56 seq.). This political change was rather an effect than a cause of coincident industrial changes, especially the introduction of private property in slaves and women. "A comparison of the American tribes, placing them in a graduated series from the primitive system of communistic equality upward, plainly shows that, at least in this part of the world the establishment of aristocracy and hereditary monarchic power has merely crowned an economic evolution, whereof the point of departure was the institution of slavery, and the consequent development of agriculture, whence arose the rupture of primitive equality, creation of exchangeable values, development of private property, contrast between rich and poor, foundation of castes, and hereditary succession" (p. 61). This passage, amongst others, betrays the tendency—fashionable in some quarters at the present time—to regard all social development as due mainly, if not wholly, to economic causes. Not that economists by profession are *gratæ personæ* to our author. On the contrary, they are only mentioned to be rebuked, and their doctrines only to be caricatured (see pp. 91, 96, cf. 120, 124, &c.). But, as by some sections of German Socialists, so by Letourneau, we are given to understand that the politics, religion, and general character of a society are determined by the conditions of industry and the terms of property therein prevailing, while no sufficient allowance is made for the reaction of the former set of phenomena on the latter.

To sum up: at this third stage in the development from savagery (the early monarchical system), the idea of personal property is extended from weapons and tools which a man has made, to the trees which he has planted, and then to the plot of ground he has cleared and sown. After that the idea of private property may be considered to be full formed and definitely launched on its modern career of development (p. 72). The great cause of private property is agriculture. Where there was only pasture, as with the Hottentots, the private property was only in cattle, women, and children (p. 79). Agriculture brings us to extended forms of slavery, and to forms of property and modes of valuing and exchanging it that approach more and more to modern ideas.

We need not follow our author into the *minutiæ* of his account of "primitive monarchies" and empires. He gives a survey of mankind from China to Peru, and from the earliest times to the period of Roman, feudal, and modern civilization. The earliest stages of the development are (rightly enough) treated more fully than the later, the later being the more generally known. The differentiation of clan from tribe and of family from clan, the formation of village communities for the purpose of agriculture, the introduction of inheritance, and of private property in estates, are all traced out in chapters that are full of interest even when not above cavil.

Prof. Letourneau has perhaps been too ready to point a moral for the benefit of his own generation. But after all he gives his readers the facts, and they may find their own moral, which may or may not be his. One of the best instances where the materials presented seem to justify a different moral than the one drawn from them is that of the *dessa* or village community of Java. It is pronounced to have excellent results, particularly in increasing population (p. 121), and is contrasted with "the selfish African system" (p. 122); but by our author's own account it is a combination of private and collective property, not an example of the latter by itself (cf. pp. 114, 115).

The book is, we may presume, translated from the French; and this will account for the use of "alienist" for "lunacy doctor" (p. 370), "disengaging" for "analyzing" (p. 373), and "salaried" for "wages-earning" (p. 375). But, as a rule, the language is correct and clear English.

J. B.

LEAPER'S "OUTLINES OF ORGANIC CHEMISTRY."

Outlines of Organic Chemistry. By Clement J. Leaper, F.C.S. Specially written for Schools and Classes connected with the Department of Science and Art. (London: Iliffe and Son, 1892.)

THIS little work is intended, as the title states, for the use of beginners. But the author has made the way of beginners hard, by leaving in his pages the largest collection of misprints and other slips which we recollect to have met with in so small a compass.

On the very first page, in the opening lines, there occurs a wrong formula for urea; and the book ends with a wrong formula for aldehyde-ammonia. We do not propose to convert this notice into a table of errata; but the following may be given as illustrating the sort of guidance which the beginner may expect. On p. 75, in the brief space of three lines, we meet with "$(COOH_2)$," "$C_3H_5(OH_3)$" and "$C_3H_5(OH_2)COOH$," as representing respectively oxalic acid, glycerin, and—monoformin! The blunder, in each case, consists, of course, in placing a coefficient inside instead of outside the bracket; but we doubt whether, even with this correction, the last expression, with its carboxyl-group in place of the group O.CHO, would be recognized, even by an experienced chemist, much less by a beginner, as representing monoformin.

Blunders, due to carelessness, are not confined to formulæ. Thus we find: "Pure white precipitate of silver *oxide* (p. 13), whereas the context shows that silver *chloride* is meant; "*ethene* dichloride, $C_2H_2Cl_2$" (p. 37); "lead the gas into lime water, and note the formation of insoluble *carbon dioxide* (p. 51); "by the further chlorination of methyl chloride we get *ethylidene* chloride" (p. 67); whilst, on p. 99, "grains" is twice given instead of "grams." But the worst blunder we have met with occurs on p. 109, where, possibly owing to a transposition of the pages of the author's manuscript, the explanations

which should follow Experiment 112 (Preparation of Ethyl Nitrite) have been moved on by a whole page, and made to follow Experiment 115 (Preparation of Nitro-ethane). The utterly bewildering effect of this jumble, which is enhanced by the unexpected re-entrance of the subject of nitro-ethane in the middle of a paragraph a little later on, cannot be realized without reading the passage.

The work is intended to combine practical with theoretical instruction. The selection of experiments is, on the whole, judicious, and the practical directions are generally good. This is not to be wondered at, as the author has evidently, in these points, followed pretty closely Prof. Emerson Reynolds's "Experimental Chemistry," even to such details as the substitution of a tin oil-can for a distilling flask (p. 99), or a peculiarity in the bending of a tube (p. 74), and to the reproduction of some of the illustrations—in every case without acknowledgment. Prof. Reynolds is not, however, responsible for the illustration on p. 17, in which the distillate from a Liebig's condenser is represented as falling from a considerable height into a flask placed below.

It is not true that (p. 12) "every organic compound containing nitrogen will, when fused with metallic sodium, convert the latter into sodium cyanide." Diazo-compounds do not yield any cyanide; and compounds containing sulphur as well as nitrogen form thiocyanate. Nor is heating a cyanide with excess of concentrated sulphuric acid (p. 76) a method of distinguishing it from a formate.

The author's style is occasionally slovenly, and sometimes worse: "Observe how the fact that oxalic acid so readily split up into CO, CO_2 and H_2O support (*sic*) this graphic formula for it" (p. 117).

On the whole, we suspect that teachers will prefer a text-book which calls for fewer marginal corrections.

OUR BOOK SHELF.

An Introduction to the Study of Botany, with a special chapter on some Australian Natural Orders. By Arthur Dendy, D.Sc., and A. H. S. Lucas, M.A. Small 8vo, 272 pages with about 30 pages of woodcuts. (Melbourne and London: Melville, Mullen and Slade, 1892.)

THE authors of this little work are both teachers of Natural Science in the University of Melbourne and it is specially intended for the use of students in Australia. With this object in view it would have been better perhaps to have selected common Australian types to illustrate the life history of the great divisions of the vegetable kingdom; but *Pinus* is taken as a representative of gymnosperms and *Vicia* of angiosperms. Whether these plants are both easily procurable in Australia we are unable to say, but even in that case it would have been better to have taken native plants Possibly the preparation of illustrations may have influenced the authors, for they are largely, in the first part, "modified," "simplified," or "adapted" figures from well-known books, or they are simply copied. Taken as a whole, we do not doubt that this primer will prove useful to students, but it needs much revision to make it what it ought to be. Here and there, where we have tested it, we have found serious shortcomings. Take for example the account of the divisions of the vascular cryptogams.

"1. *Filicineæ.*—These are the ferns which constitute a very large and interesting subdivision. The full account already given of the common bracken renders a detailed description unnecessary in this place. There are two principal subdivisions of the *Filicineæ;* the homosporous, which produce only one kind of spore, and the heterosporous, which produce large megaspores and small microspores. The former include all the ordinary ferns and are again subdivided into six 'families,' of which the Polypodiaceæ are the best known and most abundant, including most of the common ferns, such as Pteris."

One would have expected a word or two respecting the heterosporous group—the *Rhizocarpeæ*, with some mention of *Marsilea*, so memorable in the history of Australian exploration; but the authors seem to have come to grief between the older and newer classifications of vascular cryptogams, for in another place (p. 90) we read of "heterosporous ferns." The definition of the *Equisetineæ* contains no reference to the spores; and the description of the *Lycopodineæ* contains no information at all. It runs thus: "This group includes the club-mosses (*Lycopodium*) and the beautiful *Selaginella*, a plant frequently grown in conservatories for decorative purposes. They are all of rather small size, and are popularly spoken of as "mosses" owing to the general appearance of the plant with its numerous very small leaves."

Comment on such a description would be superfluous. In the classification of the cellular cryptogams, lichens are altogether left out, and are apparently not mentioned anywhere. In fact the same incompleteness and inexactness pervades the book, which opens with a eulogistic preface by W. Baldwin Spencer, Professor of Biology in the University of Melbourne. W. B. H.

A German Science Reader. (Modern German Series.) Compiled by Francis Jones, F.R.S.E. (London: Percival and Co., 1892.)

THE idea of introducing to English readers extracts from the works of many well-known German scientific authorities will be thoroughly welcomed. The author has brought together sixteen very interesting articles on several branches of science, supplemented with notes, in which difficult passages are translated, and a glossary of the technical terms not usually found in dictionaries. Among the articles we may mention, Electric Telegraphs by Bernstein; Ice and Snow by Kantz; Air by Müller; Aniline Dyes by Kekulé; Spectrum Analysis by Kirchhoff and Bunsen, &c. W.

More About Wild Nature. By Mrs. Brightwen. (London: T. Fisher Unwin, 1892.)

MRS. BRIGHTWEN'S book on "Wild Nature Won by Kindness" was so widely appreciated that she has been encouraged to prepare a second volume of the same general character. It speaks well for her knowledge of animals, and for her interest in their habits, that the new sketches are written in as fresh and bright a style as if she had never before occupied herself with the mass of subjects with which she deals. She is a careful and accurate observer, and all readers who care for natural history will find much to please them in the facts and impressions she records. The author's illustrations add greatly to the charm of the text.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Arborescent Frost Patterns.

ON Sunday last, December 4, I observed a curious phenomenon, which I do not remember having ever seen before in the streets of London. Along the Euston Road, the Marylebone

Road, and other thoroughfares having an east and west direction the paving flags were all covered with a striking, vegetable-like pattern which might be most appropriately described as an arborescent tracery. The pattern was not formed of the usual small and delicate frost figures such as we are familiar with on window panes, but was made up of large and boldly-fronded designs such as shown in the sketch, which I hurriedly made on the spot:—

The "fronds" were from one to two feet in length, and often most gracefully curved. A keen wind was blowing at the time from a few degrees north of west and the flags had evidently been coated with a thin layer of mud from the previous night's rain. I attribute the pattern to the rapid freezing and evaporation of the water in this surface layer of mud which was going on during the morning. I only noticed the tracery along east and west thoroughfares; in sheltered streets not swept by the cold wind no design was visible. The phenomenon may be known well enough to others, but by many, like myself, it may have hitherto been passed over unnoticed. My chief object in sending this description is to call attention to the very vegetable-like appearance of the pattern. If allowed to dry in a calm atmosphere and then buried under a fine alluvial or other deposit a record would be preserved which the future geologist might at first sight be tempted to read as "vegetable remains." I have seen very similar tracery in the London clay about Clacton-on-Sea and elsewhere. R. MELDOLA.

Ice Crystallites.

THE interesting facts recorded by your correspondent C. M. Irvine on p. 31 recall some unrecorded observations of my own. On several occasions during recent winters I have observed these crystallographic forms of ice on a gravel walk by the side of my lawn, in places where, owing to faulty gradients, the water does not completely drain away at the surface, and the ground just below the surface is in consequence more saturated with water than at other spots. The acicular ice-forms have appeared in bundles standing up between the pebbles and capped by earthy material, just as described by Mr. Irvine, and in previous communications to NATURE by Mr. B. Woodd Smith (see his letter on p. 79). The nature of the soil agrees with that described by these two observers, so far as permeability to water is concerned; and I think they appeared on the occurrence of clear frosty weather after a thaw and melting of previous snow. My observations, however, extended further than theirs appear to have done. I was at the time pursuing the study of the glassy acicular *crystallites* of sulphur (which are erroneously described as "crystals" in most text-books on chemistry). These, on examination with polarized light (as I have described elsewhere) are found to be destitute of any crystalline internal structure (in fact truly vitreous or isotropic masses in spite of their crystallographic outlines); such structure developing, as devitrification proceeds, by crystallization in the orthorhombic system, to which the outlines of the crystallites do not conform.

In NATURE (vol. xxxvii. p. 104) is a letter from myself, recording some observations on the vitreosity of ice, as exhibited under certain suitable conditions by hailstones, and referring to a previous letter (*Ibid.* vol. xxxvi. p. 77), wherein the vitrification and devitrification of water was suggested as the possible cause of certain structural phenomena observed in them from time to time. It was with those ideas present to my mind that during recent winters I have made an examination of the acicular ice-forms referred to, which struck me as made up of unusually clear and transparent ice. On taking my microscope out of doors, fitted with a polarizing apparatus, when the temperature was a few degrees below freezing, with a thick overcoat on to prevent the heat of one's body from affecting the ice-needles, I found that, on taking them from the ground and placing them at once on the stage between crossed "Nicols," they appeared to be *completely isotropic*, as they had no reaction on polarized light. I have concluded, therefore, that these ice-needles are strictly analogous (physically) to the prismatic crystallites of sulphur; and they resemble precisely the microscopic lathe-shaped forms, into which I have seen a perfectly clear minute plate of sulphur-glass break up in the first stage of devitrification. The explanation suggested by Mr. Woodd Smith, that they may have been formed by a slow growth of ice at their base, the molecular movement of water in the soil keeping up the supply so long as refrigeration continued, has seemed to me the most natural one; their isotropic molecular structure is no doubt due to the rapidity of freezing owing to a sudden fall of temperature at the spot. A. IRVING.

Wellington College, Berks, November 27.

The *Volucellæ* as Alleged Examples of Variation "almost Unique among Animals."

IT is barren work for the parties in a controversy merely to deny each other's statements without adducing further evidence. Mr. Bateson first stated that var. *mystacea* did not mimic *Bombus muscorum*. I replied that it did, and the statement in my letter in no way depended on the case at the Royal College of Surgeons, but on a careful comparison of the insects in the Oxford Museum. It is useless for me to repeat that I regard it as an example of mimicry, not indeed equal to that afforded by the same fly and *Bombus hortorum*, but far better than many others which are generally believed to be instances of this principle (such as the resemblance of *Clytus arietis*, or even the resemblance—admitted by Mr. Bateson in his first letter—of *Volucella inanis*, to a wasp). I therefore propose to furnish the Editor of NATURE with photographs of the *Volucellæ* and humble-bees for reproduction, so that readers can judge of the matter for themselves. I will do my best to obtain a negative which shows the coloured bands.

Although I believed that the two London Museums supported my view, it will be obvious to any one who reads the letter that I did not rely on such support, but on my own comparison of the insects.

Mr. Bateson has offered no further evidence in support of his remarkable assertion that the variation of the *Volucellæ* is unique. I am not surprised that he should pass over this part of my letter, for I felt sure that there was no further evidence to offer. It will be remembered that this evidence was contained in the "brief statement of facts" given in his first letter, and is practically summed up in the sentence "This fly exhibits the rare condition of existing in two distinct forms in both sexes." In assuming this rarity to be so excessive that the words "almost unique" may be applied to it, and in evidently considering that we must proceed as far as the peach and nectarine in order to find a parallel, Mr. Bateson exhibits a want of acquaintance with the facts of variation which is very surprising in one who is believed to have spent some years in their study. For there is no essential biological difference between this variation and many others, examples of which I gave in my last letter, and which could easily be multiplied. In fact, many a "showcase" would have corrected such a mistake. Compared with the magnitude of this erroneous statement in Mr. Bateson's first letter, the details under discussion assume very small proportions. In considering that "no speculation is needed to enhance the exceptionally interesting facts of the variation and the resemblances of the *Volucellæ*," it would appear that Mr. Bateson seeks to replace that most invaluable servant of science, speculation, by far-reaching and unsupported assertion.

In his last letter Mr. Bateson says "it is admitted that in making this statement Mr. Poulton relied not on original authorities, but on the general impression of others." So far from this being the case I stated my belief that the impression is prevalent among those who *are* original authorities on the Hymenoptera and their parasites, and I also showed that nothing

is advanced by the authorities quoted by Mr. Bateson which can be regarded as antagonistic to this impression by any one who knows a little about the working of heredity in insect varieties.

A word about "showcases." I hope that no reader of NATURE may be led to think lightly of these as a means of instruction, and as one of the chief objects of a great museum, because Mr. Bateson states that there is a wrong identification in one at the Royal College of Surgeons, and because of the distinction which he is so careful to draw between these and other cases. Some of the most valuable specimens in the world are in "showcases." They form one of the most admirable features in modern museum arrangement, and the best material obtainable is set aside for them. This is equally true on the continent and in our own country, where Prof. Sir W. Flower and Prof. Stewart have devoted an immense amount of time and labour to this department, an important recent feature of both their museums being the illustration of the uses of colouring in animals. Prof. Lankester too is developing the same method of instruction with great success in the Oxford Museum.

It is in no way remarkable or reprehensible that four recent writers (Mr. Lloyd Morgan, Mr. Beddard, Mr. Romanes, and myself) concerned with this subject and knowing the care taken in choosing these illustrations, should also make use of some of them in their published works.

One "difficulty" brought forward by Mr. Bateson is so futile that I did not allude to it before, and only refer to it now because he repeats it. He seems to think that doubt is thrown on the theory of mimicry because *V. pellucens* does not resemble a wasp, and yet lives in its nests —as if any believer in natural selection maintained that all closely allied forms must defend themselves in the same way!

As to Mr. Bateson's statement at the end of his letter that he only intended to draw attention to the matter (and not to hurt me thereby), I can only say that this statement implies an extraordinary want of acquaintance with the niceties of the English language. It is so easy to correct mistakes without leaving anything but a feeling of gratitude in the mind of one who has made them, that, in justice to Mr. Bateson's intelligence, I am compelled to doubt the accuracy of his memory.

Oxford, November 27. EDWARD B. POULTON.

"A Criticism on Darwin."

I WRITE to protest against what appears to be a growing habit on the part of certain publishing firms of advertising their books in a most misleading manner, viz. by selecting any phrase from a notice of the book which may serve to indicate that the writer's opinion on the work as a whole is favourable, whereas, if quoted with its immediate context, the passage would prove the precise opposite. For example, I see in NATURE and elsewhere an advertisement of Mr. David Syme's book "On the Modification of Organisms; a Criticism of Darwin" (Simpkin, Marshall, and Co.), in which I am quoted as having called the writer "a shrewd critic." Standing by itself these words imply that I have somewhere recommended the work as well worthy of perusal. The fact of the matter, however, is, that the words occur in a foot-note which I added to the proof of my recently published book on "Darwin and After Darwin," for the expressed purpose "of showing the extraordinary confusion of mind which still prevails on the part of Darwin's critics, even with reference to the very fundamental parts of his theory." Elsewhere in the same foot-note I refer to the writer's "almost ludicrous misunderstandings"; and conclude by saying that he "shows himself a shrewd critic in some other parts of his essay, where he is not engaged especially on the theory of natural selection." I may now add that the only parts of his essay to which these advertised words apply are those where he treats of the deleterious effects of in-breeding.

GEORGE J. ROMANES.

Animals' Rights.

I AM not surprised that you should find my essay on "Animals' Rights" an "absolutely useless" one, for I certainly did not design it to be a congenial hand-book for the apologists of Vivisection. Nor do I the least object to your drawing what conclusions you like from the premisses laid down by me, even though you seek your justification of vivisection from the very definition that seems to me to be most clearly condemnatory of it. But, as a matter of fact, and not of personal opinion, I beg to point out that you have utterly misrepresented the leading principle of the book, and that the two contradictory definitions of animals' rights, which you attribute to *my* confusion of mind, are in reality the phantom creation of your own. On p. 9, in referring to Herbert Spencer's definition of *human* rights, I claim for animals a "due measure" (not an equal amount) of the same "restricted freedom"—a claim which by no means prohibits *all* use and employment of animals, as you conveniently assume. On p. 28 I give, not a second definition, but a repetition and amplification of the one given on p. 9; and the "due measure of restricted freedom" is explained as being "a life which permits of the individual development, subject to the limitations imposed by the permanent needs and interests of the community." Surely this is intelligible enough; yet the reviewer has utterly failed to understand it. H. S. SALT.

38 Gloucester Road, N.W., November 26.

Induction and Deduction.

MISS JONES has not quite understood me. I maintain that definitions should be *arbitrary*, but not necessarily that they should be made *at random*. If they are so made it will, as she points out, seldom happen that they turn out useful, or have any real applications, though this would not affect their logical validity if it amused any one to make them and investigate their consequences. Such definitions with no real applications are actually made by pure mathematicians. The peculiar value of the definitions of geometry consists however in the fact that they have so many real applications, and it is only by a long process of survival of the fittest that a few such happy definitions are weeded out from among the many which lead to nought. The definitions of geometry could not now be laid down at random, but they are none the less arbitrary, for they require no support from any *à priori* considerations. EDWARD T. DIXON.

Trinity College, Cambridge, November 28.

The Present Comets.

I HAVE to notice the following mistake in my letter which appeared in NATURE (vol. xlvi. p. 561). I called comet Brooks, comet "*c*." I now find it should be called comet "*d*."

I have since writing been quite satisfied that the head of comet Swift extends less towards the *n* than towards the *s* (as suggested in my letter). T. W. BACKHOUSE.

West Hendon House, Sunderland, November 26.

The Afterglow.

AFTER witnessing, with Profs. Lyon and Orr, remarkable effects of afterglow on November 27, I waited for the next issue of NATURE (No. 1205), in the expectation that similar phenomena would be mentioned as having been seen in the British Isles. Curiously enough, the letter on "Afterglow" in that issue comes from Honolulu, dated November 8. It is possible, however, that the effects of volcanic dust from one of the great eruptions of the past summer are now beginning to be noticeable in opposite hemispheres. The Krakatão eruption of August 27, 1883, appears to have caused exceptional afterglows in Honolulu on September 5, and in Western Europe by November 9, in the same year.

From the top of Killiney Hill, on November 27, at 4 30 p m., we witnessed an extraordinary combination of cloud-effects, such as I do not remember having seen since the winter of 1883-4. On the west, dense clouds were forming upon Two Rock Mountain, and streaming down into the hollow of Carrickmines; but beyond them a clear golden sunset, passing above into green and intense blue, was visible above the summits of the hills. Fleecy cirrus clouds in the zenith were a delicate pink against clear blue, and this glow extended to all the higher cloud-masses in the east, until the sea itself became rose-pink by reflection. But in the extreme east the exceptional magenta tints, almost violet, that characterized many of the Krakatão glows, were strikingly apparent, though in part veiled by the low grey cloud of the Channel. These effects were at their maximum when the sun had set half an hour; they would doubtless have been of much longer duration but for the near clouds forming on the mountains.

One's thoughts at once turned to the great eruption of Sangir in the Philippines, which occurred, however, as far back as

June 7 of this year. Weather and locality have been against my seeing clear sunsets until to-day, when no unusual effects were noticeable; but Mr. Bishop's letter makes it possible that in other places similar effects may be observable.

GRENVILLE A. J. COLE.

Royal College of Science for Ireland, Dublin, December 4.

ELECTRICAL STANDARDS.

THE following supplementary report has been presented to the President of the Board of Trade by the Electrical Standards Committee :—

To the Right Hon. A. J. Mundella, M.P., President of the Board of Trade.

Subsequently to the presentation of our former report to Sir Michael Hicks-Beach in July, 1891, we were informed that it was probable that the German Government would shortly take steps to establish legal standards for use in connection with electrical supply, and that, with a view to secure complete agreement between the proposed standards in Germany and England, the Director of the Physico-Technical Imperial Institute at Berlin, Prof. von Helmholtz, with certain of his assistants, proposed to visit England for the purpose of making exact comparisons between the units in use in the two countries, and of attending the meeting of the British Association which was to take place in August in Edinburgh.

Having regard to the importance of this communication, it appeared desirable that the Board of Trade should postpone the action recommended in our previous report until after Prof. Helmholtz's visit.

That visit took place early in August, and there was a very full discussion of the whole subject at the meeting of the British Association in Edinburgh, at which several of our number were present. The meeting was also attended by Dr. Guillaume, of the Bureau International des Poids et Mesures, and Prof. Carhart, of the University of Michigan, U.S.A., who were well qualified by their scientific attainments to represent the opinion of their respective countries.

It appeared from the discussion that a few comparatively slight modifications of the resolutions included in our previous report would tend to secure international agreement.

An extract from the report of the Electrical Standards Committee of the British Association, embodying the results of this discussion, was communicated to us by the Secretary, and will be found in the appendix to this report.

Having carefully reconsidered the whole question in view of this communication, and having received the report of the sub-committee mentioned in resolution 14 of our previous report, we now desire, for the resolutions contained in that report, to substitute the following :—

RESOLUTIONS.

(1) That it is desirable that new denominations of standards for the measurement of electricity should be made and approved by Her Majesty in Council as Board of Trade standards.

(2) That the magnitudes of these standards should be determined on the electro-magnetic system of measurement with reference to the centimentre as unit of length, the gramme as unit of mass, and the second as unit of time, and that by the terms centimetre and gramme are meant the standards of those denominations deposited with the Board of Trade.

(3) That the standard of electrical resistance should be denominated the ohm, and should have the value 1,000,000,000 in terms of the centimetre and second.

(4) That the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice 14·4521 grammes in mass of a constant cross sectional area, and of a length of 106·3 centimetres may be adopted as one ohm.

(5) That a material standard, constructed in solid metal, should be adopted as the standard ohm, and should from time to time be verified by comparison with a column of mercury of known dimensions.

(6) That for the purpose of replacing the standard, if lost, destroyed, or damaged, and for ordinary use, a limited number of copies should be constructed which should be periodically compared with the standard ohm.

(7) That resistances constructed in solid metal should be adopted as Board of Trade standards for multiples and submultiples of the ohm.

(8) That the value of the standard of resistance constructed by a Committee of the British Association for the Advancement of Science in the years 1863 and 1864, and known as the British Association unit, may be taken as ·9866 of the ohm.

(9) That the standard of electrical current should be denominated the ampere, and should have the value one-tenth (0·1) in terms of the centimetre, gramme, and second.

(10) That an unvarying current which, when passed through a solution of nitrate of silver in water, in accordance with the specification attached to this report, deposits silver at the rate of 0·001118 of a gramme per second may be taken as a current of one ampere.

(11) That an alternating current of one ampere shall mean a current such that the square root of the time-average of the square of its strength at each instant in amperes is unity.

(12) That instruments constructed on the principle of the balance, in which, by the proper disposition of the conductors, forces of attraction and repulsion are produced, which depend upon the amount of current passing, and are balanced by known weights, should be adopted as the Board of Trade standards for the measurement of current whether unvarying or alternating.

(13) That the standard of electrical pressure should be denominated the volt, being the pressure which, if steadily applied to a conductor whose resistance is one ohm, will produce a current of one ampere.

(14) That the electrical pressure at a temperature of 15° centigrade between the poles or electrodes of the voltaic cell known as Clark's cell, prepared in accordance with the specification attached to this report, may be taken as not differing from a pressure of 1·434 volts, by more than one part in 1000.

(15) That an alternating pressure of one volt shall mean a pressure such that the square root of the time-average of the square of its value at each instant in volts is unity.

(16) That instruments constructed on the principle of Lord Kelvin's quadrant electrometer used idiostatically, and, for high-pressures, instrument on the principle of the balance, electrostatic forces being balanced against a known weight, should be adopted as Board of Trade standards for the measurement of pressure, whether unvarying or alternating.

COURTENAY BOYLE. G. CAREY FOSTER.
KELVIN. R. T. GLAZEBROOK.
P. CARDEW. J. HOPKINSON.
W. H. PREECE. W. E. AYRTON.
RAYLEIGH.
T. W. P. BLOMEFIELD, Secretary.

November 29.

ON THE PHYSIOLOGY OF GRAFTING.[1]

THE volume before us contains the record of several years of research upon the effects of different forms of grafts (using the term in its widest significance) in the vegetable kingdom.

[1] "Ueber Transplantation am Pflanzenkörper. Untersuchungen zur Physiologie und Pathologie" Von Dr. Hermann Vöchting. Mit 11 Lithographierten Tafeln und 14 Figuren im Texte. (Tübingen: Laupp, 1892.)

Opening with an historical introduction which deals briefly with the development of the art from classical times down to the present day, the author proceeds to indicate the general scope of his own investigations, and to describe the methods of experiment which he employed. The immediate problems which he sets himself to solve are contained in two questions which occur on an early page of his book, namely—Is it possible to remove parts of a given plant and transplant them to any other position in the same or a similar plant? And upon this question follows the second—What is the nature of the reaction which occurs between the newly-introduced portion and the surrounding tissues?

But although these form the proximate questions which are to be answered by means of a large number of well-conducted experiments, it soon becomes clear to the reader that the chief interest which attaches to the results obtained depends on their application to the theory of polarity of cells and tissues which Prof. Vöchting has already put forward elsewhere.

The plants chiefly (but by no means exclusively) used in the investigations were *Beta vulgaris* and *Cydonia japonica*. The former is of a fleshy and succulent character, whilst the latter is a woody plant which happens to be specially adapted to the various operations of grafting, and, as it is a perennial, it admits of the results of the experiments being watched for a considerable period of time. Prof. Vöchting distinguishes in every part of the plant between a "shoot-pole" and a "root-pole," and these he considers to be always present, however small the plant member, or piece of excised tissue, may be. The polarity manifests itself at the free surfaces, much as the effects of the magnetism of a bar magnet are visible at its ends; and moreover, just as the pieces of a broken magnet are themselves duly polarized, so also fragments of tissue exhibit relations of polarity identical with those characteristic of the organism from which they were derived

The first precaution necessary to secure success in grafting is to respect the existences of the shoot- and root-poles, and to insert the scion in such a way as to bring its poles into due correspondence with those of the stock. Acting upon this principle it is found that, generally speaking, any member may be grafted on any other member unless there is some special reason to the contrary, such as may be connected, for example, with nutrition or water-supply. The leaf of the beet will "take" if grafted on a root, and *vice versa*, and it was also found that it was possible, in the case of roots with diarch bundles, to effect a union even when the xylem planes in the two portions were made to cross each other at right angles; analogous results were also obtained with leaves. Hence the author concludes that there is no inherent fixity in the organization of plants which predetermines a definite sequence of the chief members of which they are composed.

Experiments were made with the object of determining the mutual reactions between the stock and the scion, and the conclusion arrived at is that beyond such changes as may be referred to nutritional and similar causes, the two remain unaltered, at least in so far as their specific characters are concerned. Prof. Vöchting criticises unfavourably the various alleged cases of the so-called "graft-hybrids," and points out that even in one of the best authenticated examples, that of *Cytisus Adami*, all attempts to produce the hybrid afresh have resulted in failure.

The most interesting part of the book is occupied with the account of researches into the behaviour of transplanted portions of tissue, the direction of whose "polarity" does not coincide with that of the parts into which they are introduced. When the inserted portion of tissue is rotated on its longitudinal axis so that its own tangential surfaces are applied to the radial ones of its new host, difficulties arise in the accomplishment of a complete union, and these difficulties are further increased to a maximum when the tissue is put in upside-down, so to speak, that is with its own poles presented to *similar* poles in the stock. A great number of experiments were instituted to investigate these reactions, but space forbids any attempt to do more than briefly summarize the most important points. In the case of *Cydonia japonica* a ring of rind was cut out of a twig and replaced in the reversed direction. In many cases the twigs behaved as if the tissue had not been restored at all, simply dying, whilst in others a subsequent healing took place. This healing was accompanied by a swelling at the upper junction, together with the appearance of a ridge of tissue which was formed along the longitudinal suture of the ring from above downwards and was derived from the cambium of the ring, and not by an ingrowth of callus from the uninjured cortex of the twig, as might perhaps be supposed. In this way connection between the interrupted rind was re-established, and growth recommenced. But both at the edges of the tissue-ridge, and also between it and the original underlying xylem, the cell elements were found to be disposed in a remarkable manner, forming curved unions with the cells of the healthy tissues. For the histological details the reader is referred to the original treatise; suffice it to say that Prof. Vöchting believes that he has found in the appearances thus presented, additional evidence for the validity of his theory of the polarized condition of living tissues. He conceives of these polarities as properties which are the expression of the innermost relationships existing between the constituents of which cells are built up. He further regards the polarity of any tissue as irreversible when once the direction has been imparted to it, and he finds justification for this view not only in the details of his own experiments on grafting, but also in the results of investigations conducted by Kny and others, on the effects of compelling parts of plants to grow in a reversed position. After discussing some of the objections to his theory, without, however, disposing of them all, the author concludes by stating, with considerable reserve, some of the wider applications of his theory in explaining geotropism and other allied phenomena.

The book certainly forms one of the most important of the recent contributions to plant physiology, and the experimental details are well illustrated in the eleven plates which accompany the text, whilst the diagrams in the body of the work serve to render the author's theoretical views more intelligible.

J. B. F.

NOTES.

A GOLD MEDAL is to be presented to M. Pasteur on December 27, his seventieth birthday.

ON Monday Lord Durham laid the foundation stone of a new wing of the College of Science, Newcastle, which, like the College of Medicine in the same city, is a branch of the Durham University. The College of Science was established at Westgate-hill, Newcastle, in 1871. Lord Armstrong laid the foundation stone of the present premises at Barras Bridge in 1887, and in the following year the existing wing was opened by the Marquis and Marchioness of Lorne. The success of the institution is strikingly indicated by the fact that the increase in the number of students has rendered a new wing absolutely necessary.

DR. WERNER SIEMENS, the well-known electrical engineer, died at Berlin on Tuesday. He was seventy-six years of age.

MR. W. H. PREECE, F.R.S., has been appointed a member of the Royal Commission on Electrical Communication with Lighthouses, &c., in the place of Mr. Edward Graves, deceased.

Mr. W. Mattieu Williams, who had a considerable reputation as a metallurgist and a popular writer on scientific subjects, died at his residence, near Willesden, on November 28. He was in his seventy-fourth year. Among his writings are his well-known books on "The Fuel of the Sun," "Science in Short Chapters," and "Through Norway with a Knapsack."

We have to record the death of two distinguished Continental cryptogamists, Dr. F. v. Thümen, the well-known mycologist, formerly Director of the Chemico-Physiological Experiment Station at Klosternenberg; and Dr. C. M. Gottsche, of Altona, one of the authors of the *Synopsis Hepaticarum*, and one of the leading authorities on Mosses and Hepaticæ, in the eighty-fourth year of his age.

The Master and Fellows of Gonville and Caius College, Cambridge, have elected as Honorary Fellows the following graduates of the college:—Alexander Henry Green, F.R.S., bracketed sixth Wrangler, 1855, formerly a Fellow of the College, late Professor of Mathematics, Yorkshire College of Science, now Professor of Geology, Oxford; Arthur Ransome, M.D., F.R.S., First-class Natural Sciences Tripos, 1856, Physician to the Manchester Hospital for Consumption and Diseases of the Throat; and George John Romanes, F.R.S., Sir Robert Rede's lecturer, 1883, late Professor of Physiology in the Royal Institution of Great Britain.

An important conference on technical education was held at Newcastle on Saturday. It was summoned by the Technical Education Committee of the Northumberland County Council. Sir M. White Ridley, the Chairman of the Council, said that the scheme of the Technical Education Committee, generally speaking, had opened out two progressive educational roads from the elementary day school onward—first, for day scholars, by means of scholarships; and secondly, for evening students by a graduated system of classes. The work in progress under that scheme had already been very extensive. As regarded agriculture, there had been courses of lectures, on manuring land, poultry-keeping, farm stock, dairy work, &c. Educational courses had been given in mining, mechanics, electricity, engineering, ship-building, &c. As regarded the fishermen also, a very successful method had been adopted of teaching the men a few plain scientific facts with regard to coastal navigation, the habits of fishes, and so on. After the delivery of the Chairman's speech the Committee's scheme was carefully discussed.

Prizes and certificates in connection with the City and Guilds of London Institute will be presented on Monday, December 12, at Merchant Taylors' Hall, Threadneedle-street, by Mr. William Anderson, F.R.S The Lord Mayor will preside.

At the General Monthly Meeting of the Royal Institution on Monday, the special thanks of the members were returned to Mr. Ludwig Mond for a donation to the fund for carrying on investigations on liquid oxygen.

Mr. Streeter held a reception on Saturday at 18 New Bond Street for the first display of sapphires from the Montana mines. At the same time an assortment of chrysoprase jewels was exhibited, and also a black diamond, said to be the largest yet discovered. Mr. Streeter also showed, among other things, a collection of different specimens of pearl-bearing oyster shell, and some curious formations of pearls in shell and loose, and in a variety of natural colours.

In the current number of the *Geological Magazine* it is noted that Mr. Joseph E. Carne, Curator of the Mining and Geological Museum, Sydney, New South Wales, who so ably assisted the late Mr. C. S. Wilkinson during the Mining and Metallurgical Exhibition at the Crystal Palace, Sydenham, in 1890, has been appointed by the Minister of Mines to the post of Geological Surveyor. Mr. Carne entered the service of the New South Wales Government in 1879.

The French Association for the Advancement of Science has received from an anonymous donor the sum of 600 francs, to be given in two prizes (of 400 and 200 francs), to the authors of the best memoirs containing an investigation, according to local documents, of the frequency of rabies, and the prophylactic measures in operation in a department of France, *la Seine excepted*, or in a region (two or three departments) of France or of Algeria. The statistical figures must relate to ten years at least, and comprise the results of 1892. Manuscripts to be sent to the secretary in Paris before March 31, 1893. The following points are noted for investigation:—The number of rabid animals, of dogs, of persons bitten, and dead through rabies, also of those vaccinated at the Pasteur Institute; separate the cases of rabies in large towns from those in the rest of the department; measures of sanitary police, their effect and difficulty of application; causes of more or less frequency of rabies, and of vaccination; measures taken in frontier departments, &c.

Dr. B. Pasquale has undertaken a study of the phenomena and causes of the very destructive disease of the vine known as "mal nero," his observations having been made chiefly in Sicily. The disease makes its appearance in the form of black spots and streaks on the leaves. Dr. Pasquale finds it to be always accompanied by a Schizomycete, which he believes also to be its cause, and which is parasitic, especially on the tissues rich in protoplasm and in other plastic substances, such as the cambrium, the medullary rays, the cortical parenchyma, and the soft bast of the axile organs.

The *Botanical Gazette* states that, in a report to the Cornell University, Prof. L. H. Bailey firmly establishes the commercial value of the electric light for certain winter crops, especially for lettuce. Certain kinds of plants, which are injured by the direct rays of the light, are not injured, but may even be benefited, when the light passes through a clear glass globe or through a glass roof. Auxanometric records appear to show that the light accelerates growth, but does not change its normal periodicity. This is in harmony with the observations of Prof. G. Bonnier, recorded in the *Comptes rendus*, who finds that the electric light promotes the formation of chlorophyll in all kinds of plants, both woody and herbaceous.

The third appendix, 1892, of the *Kew Bulletin* has been issued. It consists of a list of the staffs of the Royal Gardens, Kew, and of botanical departments and establishments at home and in India and the colonies, in correspondence with Kew.

M. Edouard Branly, Professor of Physics at the Ecole Libre des hautes études, Paris, writes to us to complain that experiments made by him are attributed to Mr. Dawson Turner in our account of "Physics at the British Association" (Nature, August 18, p. 384). We learn that in Mr. Turner's paper, and in the condensed report furnished by him for publication, full justice was done to Prof. Branly's work. The reference to Prof. Branly was unintentionally omitted when the report was being cut down for Nature.

Messrs. Macmillan & Co. will publish immediately a new book by Professor Oliver Lodge, entitled "The Pioneers of Science." In this volume, which will be fully illustrated with portraits and diagrams, the author describes in popular language the history and progress of Astronomy. His aim has been to state scientific facts and laws as simply as possible, to present in turn a living figure of each Pioneer, and to trace his influence on the progress of thought.

During the past week barometric depressions have reached our western coasts with considerable frequency. As these dis-

turbances were passing away from our islands, sharp frosts occurred in the north, where the shade temperature fell as low as 13° in the north of Scotland on Thursday, December 1. The gales which accompanied the depressions were confined more particularly to the north and west. On Saturday, the 3rd instant, a large cyclonic disturbance appeared from off the Atlantic, and in the rear of this cold north-westerly winds set in with snow or hail showers generally; in many parts of the country the snow was sufficiently heavy to interfere seriously with traffic. The temperature continued to decrease, the highest daily maxima being generally below the average for the time of year, and at places in the north and north-east of our islands the maximum thermometer at times did not rise above the freezing point. For the week ended the 3rd instant the official reports show that the rainfall was greatly in excess in Scotland, and rather so in the south of England and some of the western districts; but in the eastern parts of Great Britain, and in the north of Ireland, there was a deficiency. In the south-west of England the deficiency, from the beginning of the year, is still very great, being 22 per cent. of the average amount.

MR. H. C. RUSSELL, in his presidential address to the Royal Society of New South Wales, mentions a very curious drift of a "current bottle" thrown from the Austrian man-of-war *Saida*, about half-way between Sydney and New Zealand. This bottle found its way through twelve degrees of latitude and four of longitude to the coast of Australia, two miles north of Tweed River, where it was found just eleven months after it was thrown into the sea. Mr. Russell states that from what is known of the currents, which set strongly to the south along the coast of Australia, it seems impossible that it could have travelled direct, and that it was therefore probably carried eastward to the coast of New Zealand, and thence northward towards New Caledonia, until it got into the current setting from there to the coast of Australia; a journey of at least 2,500 miles in 335 days, and doubtless subject to many deviations which made its course longer and all the more surprising.

M. W. PRINZ, secretary of the Belgian Microscopical Society, has published an interesting paper on filiform inclusions in the quartz of St. Denis, Mons, which strangely simulate organic structures. He has at the same time discussed the origin of moss-agates, and has repeated the experiments with colloid silica and certain salts by which very similar appearances are produced. The paper, which is illustrated with a plate, is a valuable contribution to the literature of a very interesting subject.

MR. W. HOLLAND contributes to the December number of the *Entomologists' Monthly Magazine* some good practical hints on sugaring. Moths, he says, often come more readily when sugar is applied to the twigs and branches of the trees they feed upon, or twigs of something near their food-plant, than they will to sugar placed on the trunks of trees; *Xanthia citrago*, for instance, will hardly come at all to sugar put on the trunk of the lime tree; an occasional one only will be got in this way, but by sugaring below the tips of the outermost branches all round the tree Mr. Holland generally finds about fifty on one tree, besides other species. In the case of *Xanthia aurago* again, the best place to sugar is along the outside of the beech wood beneath the ends of the overhanging branches, or on the twigs of the hedge below them. Mr. Holland has repeatedly taken about 100 in a night in this way, when trunks sugared inside and outside the wood have not yielded one specimen. Other things may be got in the same way by selecting the place according to the species wanted. Among other points to which he calls attention is the necessity of recognizing early what is going to be a species of the year, for every year brings some particular kind more plentifully than usual. The sugar Mr. Holland uses is "Egyptian raw," a date sugar. This is very dark and strong stuff, sand-like, and free from lumps, and it mixes easily without boiling. He simply mixes it with beer, and then adds a drop or two of essence of pears just before starting out. There is rum enough in good sugar, and to add more is only to make the moths drop off before they can be bagged. "Jamaica foots" is a good sugar too, but it is lumpy and needs boiling. Old black treacle will do fairly well as a bait, but "golden syrup" Mr. Holland believes to be a fraud. Beet-root sugars, or refined sugars, are of course bad, and if he happens to be in a place where he can get only these, then, and then only, he adds rum.

THE second volume of the Transactions of the Leeds Naturalists' Club, to which we referred last week, includes an interesting paper on the structure and life-history of a fungus, by Mr. Harold Wager, assistant lecturer and demonstrator in biology, in the Yorkshire College, Victoria University. The paper deals with a small microscopic fungus, *Peronospora parasitica*, as a type of the fungi. Mr. Wager points out that, although in some respects this may not be the best type for the purpose, it has the advantage of having a comparatively simple structure and method of development easy to understand, and serving as an excellent introduction to the morphological study of the fungi. This type is also the more interesting because many structural details, which are fully described by Mr. Wager, have been more fully worked out in it than in any other. The paper is carefully illustrated, and the author gives a useful summary of the methods employed in the examination of the various structures he mentions.

A NOVEL utilization of aluminium is that for the construction of aluminium slate-pencils. Major von Sillich, of Meiningen, found that aluminium gives a stroke on a slate, and a German company has undertaken the manufacture of pencils based on that fact. They are 5mm. thick and 14mm. long. They need no pointing, and are well-nigh inexhaustible and unbreakable. The writing, which is as clear as with ordinary pencils, requires a little more pressure. It can be erased with a wet sponge.

A COLORIMETER for comparing the intensity of colour in a solution with a standard solution has been constructed by Papasogli. It consists of two graduated cylindrical vessels of equal diameter, through which light is transmitted from below. A vertical telescope fixed above the tubes shows the two halves of the field equally illuminated if the amounts of coloration are the same. If they are not, the heights of the liquids in the tubes can by a simple contrivance be so regulated that the colours have equal shades. Under these conditions, the concentration of colouring matter is inversely proportional to the length of the column of liquid tested.

THE Trinidad Field Naturalists' Club has held its first annual meeting, and has evidently good reason to congratulate itself on its success, which has surpassed the highest expectations of the members. Mr. Caracciolo, the chairman, in his presidential address, reminded the club that the gardens, plains, mountains, and rivers of Trinidad swarm with animal forms, about a good many of which very little is yet known.

THE latest instalment of the Transactions of the Institution of Engineers and Shipbuilders in Scotland includes the address by Mr. Robert Dundas, president, at the opening of the present session. Speaking of railways, Mr. Dundas said that a continual improvement in rolling stock generally can be noted. Larger and more commodious carriages are gradually taking the place of the smaller ones, and there is a marked increase in the application of the bogie principle, which does well, and makes an easy running carriage when properly constructed.

"Long carriages," said Mr. Dundas, "cannot be built to go round ordinary curves without either a bogie or radial axle; and between the two experience leaves very little doubt as to which is the better. The radial axle is an awkward arrangement, and does not act with the same smoothness as a well-constructed bogie with properly balanced springs to regulate its motion, and a bogie of short wheel base is not so good as a long one; the wheel base should always be more than the gauge to produce good results. There is no better test to determine what is good or bad in rolling stock than the effect on the permanent way."

A VALUABLE paper on the copper resources of the United States, read by Mr. James Douglas before the Society of Arts on November 30, is printed in the current number of the Society's journal. Mr. Douglas notes that though for many years no new copper mine has been opened, the larger and richer ones, which have been able to maintain existence in the face of depressed prices, are directing their efforts, not so much towards increasing their capacity for production as towards reducing the cost of reduction, saving, as far as possible, the precious metals associated with their ores, and securing for themselves the profits which have heretofore been made by the refining companies, to whom they sold their furnace material. "The effect of this change of policy," said Mr. Douglas, "may tell upon the market. It certainly will affect the copper refineries of this country and the continent. It would seem, therefore, that the era of rapid expansion is drawing to its close, and a healthier one of economical treatment is being inaugurated. The demand for copper is so great, that, if this policy be pursued by the large existing mines, there will be room for the appearance of new competitors, without imminent risk of over-production."

MR. W. J. L. ABBOTT contributes to the new instalment of the Proceedings of the Geologists' Association an interesting note on the occurrence of walrus in the Thames valley. *Trichechus rosmarus*, Linn., has been recorded from several places on the east coast, from the Dogger Bank, and from the peat near Ely. In the Thames valley it was discovered at a depth of 33 feet 2 inches during the excavations for the new London Docks. It was, however, considered to have "tumbled down from above," and so was passed by. In 1888 Mr. Abbott saw a tusk taken out of the gravel in the course of excavations for a wharf in Upper Thames-street; it was associated with bones of pachyderms. Although he felt sure of its identity, he was unable to procure the specimen, probably because his eagerness to obtain it manifested itself to the workman, who immediately affected that he would not part with it. Not long afterwards, in an excavation between Leadenhall and Fenchurch streets a number of bones were taken out of the gravel which underlies the peat, which in turn underlies the Roman layer. The upper part of the gravel is stained somewhat by the peat, as are the contained bones. Amongst the latter there was a large part of the skull of a walrus, with one tooth still left *in situ*, the others having been destroyed in the rough usage to which it had been submitted in bygone times. The state of preservation is seen to be exactly similar to that of the other bones found with it; while its position, Mr. Abbott thinks, leaves no question as to its Pleistocene age. He holds therefore that in future *Trichechus rosmarus* should be added to the Thames valley fauna.

AT the meeting of the chemical section of the Franklin Institute on October 18, Mr. Palmer read a note on a lilac colour from extract of chestnut. He said that in experimenting with a commercial extract of chestnut wood, with the idea of making galloflavine therefrom, he had obtained an unlooked-for result. The extract was somewhat fermented; that is a part of the tannin had been changed into gallic acid; and the design was to convert this gallic acid into galloflavine by the usual method. A solution of the 51° extract was made strongly alkaline with potash, and subjected to the action of a stream of air for about ten hours. The temperature, meantime, was kept below 50° F. At the end of the period of oxidation the potash was neutralized with acetic acid. The solution so obtained was tested for galloflavine by working therein cotton and wool yarns with the addition of potash alum. While no yellow colour was obtained, a clear, bright lilac was developed on both the animal and the vegetable fibre. The body giving this colour has not as yet been separated from the oxidized extract.

A BOOK entitled "Mind and Matter: an Argument on Theism," by the Rev. James Tait, of Montreal, has been so well received that a third edition, revised and enlarged, has just been issued (London: C. Griffin and Co.). Whatever may be said of Mr. Tait's theology, he has a good deal to learn as to the temper in which the consideration of scientific problems should be approached. It seems a little foolish, at this time of day, to talk about the "horrible plaudits" which "have accompanied every effort to establish man's brutal descent."

A PAPER embodying various suggestions to travellers was read at the June meeting of the Queensland branch of the Royal Geographical Society of Australasia by Mr. J. P. Thomson, the honorary secretary of the Society. The paper, revised and enlarged, has now been reprinted from the Society's "Proceedings and Transactions."

THE Society for Promoting Christian Knowledge has issued a new edition of "Sinai: from the Fourth Egyptian Dynasty to the Present Day," by the late Major H. S. Palmer. The little book has been revised throughout by Prof. Sayce.

MESSRS. NEWTON & Co. have issued a catalogue of science lanterns, magic lanterns, dissolving view apparatus, and lantern slides, manufactured and sold by them. The catalogue is accompanied by a supplementary list for season 1892–93.

THE additions to the Zoological Society's Gardens during the past week include a Lesser White-nosed Monkey (*Cercopithecus petaurista* ♂) from West Africa, presented by Mr. W. H. Henniker; two Great Kangaroos (*Macropus giganteus* ♀ ♀) from Australia, presented by Sir Francis Wyatt Truscott, J.P., F.Z.S.; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Miss Truefitt; a Sykes's Monkey (*Cercopithecus albigularis* ♀) from West Africa, deposited.

OUR ASTRONOMICAL COLUMN.

COMET HOLMES (NOVEMBER 6, 1892).—Computations of the orbit of this comet show now that it is an elliptic one, the period extending to 6·78 years, very nearly the same as that of Wolf Comet, 1884 III.–1891 II. The time of perihelion occurred on June 20·7357 of this year, and the comet's orbit may be mentioned as lying wholly between those of the planets Jupiter and Mars.

The following elements and ephemeris are due to Mr. A. Berberich, and are derived from observations made on November 9 (Karlsruhe), November 18 (Hamburg), and November 25 (Berlin):—

Elements.

Epoch 1892, November 25·5 Berlin M.T.

$$\begin{aligned} M &= 22^\circ\ 56'\ 3''\!\cdot\!6 \\ \pi - \Omega &= 18\ 12\ 14\cdot8 \\ \Omega &= 331\ \ 4\ 23\cdot2 \\ i &= 20\ 39\ 38\cdot8 \\ \phi &= 23\ \ 9\ \ 0\cdot6 \\ \mu &= 523''\cdot335 \\ \log a &= 0\cdot554151 \end{aligned} \quad \left.\begin{matrix} \\ \\ \\ \end{matrix}\right\} \text{Mean Equator, 1892.0}$$

Ephemeris. Berlin Midnight.

1892.	R.A. h. m. s.	Decl. ° ′	Log Δ.	Log *r*.
Dec. 8	0 45 33	+35 23·6	0·2580	0·3958
9	46 3	35 18·4		
10	46 34	35 13·4		
11	47 7	35 8·5		
12	47 41	35 3·7	0·2696	0·3981
13	48 17	34 59·0		
14	48 55	34 54·4		
15	49 34	34 50·0		

A NEW COMET (BROOKS, NOVEMBER 20).—On the evening of November 20 a telegram was received at Kiel announcing the discovery of a new comet by Brooks on November 20. Its position on November 20·875, Greenwich M.T. was given as R.A. 12h. 57m. 40s., Decl. + 13° 25′. Its physical appearance was described as "circular, diameter equal to 1′, brighter than a third magnitude star, some eccentric condensation, no tail."

From observations made on November 21, 24, and 26, Prof. Kreutz has found the following elements and ephemeris, which has been communicated by a Kiel circular post-card :—

Elements.

T = 1893, January 6·953, Berlin M.T.

$$\omega = 84^\circ\ 24'\!\cdot\!5$$
$$\Omega = 185\ 10\cdot7$$
$$i = 143\ 18\cdot6$$
$$\log q = 0\cdot08130$$

Ephemeris, 12h. Berlin M.T.

1892.	App. R.A. h. m. s.	App. Decl. ° ′	Log Δ.	Br.
Dec. 8	13 28 54	+24 18·5	0·0876	2·3
12	13 39 55	28 20·5	0·0449	2·9
16	13 54 6	33 17·1	0·0001	3·7
20	14 13 17	39 19·3	9·9550	4·6
24	14 41 4	46 30·1	9·9126	5·7

A NEW COMET.—The comet which on the 24th was discovered by Mr. Freeman is now supposed most probably to be a nebula.

THE CHANNELS OF MARS.—In our Astronomical Column for November 17 we referred to the most recent hypotheses that had been put forward with respect to the doubling of the channels on the surface of Mars. Another suggestion has lately come under our notice, and this, although explaining the phenomena in quite a different way, has a point or two in its favour. This explanation appeared in the *Shanghai Mercury* on October 14, and was written by Mr. T. W. Kingsmill, the following being a brief summary of the main points :—

As Mars revolves round the sun, under the rule of gravitation, she must have tides on her surface, and since her moons are not sufficiently large to cause any sensible rise, her tides must be mostly solar. Now the best views we have of this planet is when he is in opposition, that is when we are interposed between him and the sun, so that we should always see him best at high tide. The writer then makes rather a strong point of the great eccentricity of the orbit of Mars, and the consequent heavy fall which he makes when plunging towards the sun. Situated further from the sun than we are, Mars of course must be reckoned as an older member of our system, and since he is smaller than our earth, it is only natural that his surface crust would be thicker than ours. Granting this then the internal pulp would not have such a power to compensate for this rapid fall, as our earth does internally, for there would not be much of it, so that an external compensation, assuming the crust to be too thick to alter its form, would have to take place at the surface. On the surface of course the water is the only available power, therefore we should expect, to put it in Mr. Kingsmill's own words, "that the water in the ocean would be projected into the Martial hemispheres, and as the planet approached the sun, solar tides would sweep round the planet; that the canals should sometimes appear and sometimes be duplicated . . . . is only what *à priori* might be anticipated."

Those interested in this question will be glad to hear that M. Stanislas Meunier (*Comptes rendus* for November 21, No. 21) has been continuing his experiments on this subject, which we referred to a fortnight ago. He finds now that by employing a metallic sphere instead of a polished mirror, and covering its surface with the veil as he did his former experiments the results are more striking, and bring out more clearly the phenomena really observed on the planet's surface.

ASTRONOMY AND ASTROPHYSICS.—The November number of *Astronomy and Astrophysics*, among many of its interesting articles contains one by Prof. Pickering on the lunar atmosphere, which will be read with much interest. Accompanying the article is an illustration of the recent occultation of Jupiter, at which time a dark band tangent to the moon's surface but on the planet was both observed and photographed. Prof. Coakley writes on the "Probable origin of Meteorites," the conclusions which he draws referring their origin to prehistoric lunar eruptions.

Prof. Hale, in addition to several articles on solar physics, describes generally the proposed new giant Chicago refractor, and from all accounts the observatory when finished and ready for work will be operated by simply pressing buttons; the observing chair will be entirely eliminated, the floor of the observatory, capable of motion in the vertical direction, serving the purpose. Mr. W. W. Campbell gives rather a lengthy account of his observations on the spectrum of the late Nova, and the result may be summed up in the words, "While the hypothesis of two bodies quite generally satisfies the observations, and has the further very great advantage of simplicity, there are a few not unimportant points furnished by the photographs which favour the existence of three or four bodies, two or three yielding bright line spectra and one a dark line spectrum."

A NEW OBSERVATORY.—M. S. de Glasenapp recently announced to the French Academy of Sciences that a new astronomical observatory has been erected at Abastouman, in the government of Tiflis. The observatory has been called Géorgieioskaja, in honour of its founder, and it is situated at a height of 1393 metres above the level of the sea, its terrestrial co-ordinates being latitude + 41° 45′ 43″ longitude, east of Paris 2h. 41m. 58·5s. At present it is provisionally supplied with a refractor of about nine inches belonging to the St. Petersburg University. Work has already been begun, and from all accounts the situation seems to be most favourable, many double stars measures having been obtained, which in ordinary circumstances are accounted very difficult objects with such an aperture. The observatory was opened on August 23 of this year, and up to November 5 as many as 400 double stars have been measured, omitting observations of the total lunar eclipse and of some phenomena of Jupiter's satellites.

GEOGRAPHICAL NOTES.

DR. KARL DIENER has returned to Vienna from his geological expedition in the Himalayas, which has resulted in important additions to the data available for a geological description of the great mountain system. In June the expedition commenced work in North Kumaon, crossing the Utadurrha Pass (17,600 feet), and after more than three months spent amongst the border ranges of Tibet, returned to India by the valley of Alaknanda. For a month the party never camped at a less height than 14,500 feet, and the highest summit reached was over 19,000 feet.

DR. NANSEN is threatened with a serious rival in Lieutenant Peary, who has obtained leave from the United States Navy for three years to be spent in Arctic exploration. The base of his projected journey would be the farthest point reached by him on his recent journey in Greenland, and "an incidental object" would be to reach the pole by travelling over the frozen surface of the sea which he believes to surround it.

FRIEDRICH HELLER VON HELLWALD, well known as a writer on geography and ethnology, died on November 1, aged fifty years. He was born at Padua, and grew up with an equal knowledge of German and Italian, a fact to which much of his ultimate success as an author may have been due. He was an officer in the Austrian army, but devoted most of his time to historical research and literary work. His earliest work, "Amerikanische Völkerwanderung," appeared when he was twenty-four years of age, and later he wrote on the Russians in Central Asia, the native people of various parts of Asia, the history of civilization, and other subjects. His "Die Erde und ihre Völker" formed the basis of Stanford's "Compendium of Geography and Travel." For many years Hellwald edited the geographical journal *Das Ausland*.

Captain H. L. Gallwey, vice-consul for the Oil Rivers Protectorate, gave, at the meeting of the Royal Geographical Society on Monday, a detailed account of his travels in the Benin country, of which notice has already been taken in this column (vol. xlvi. p. 65). The fact that some of the deltaic streams are clear and transparent, while the Niger water is very muddy, makes it probable that they are small independent rivers. An account of a visit to Benin city gives some idea of the decadence of native West Africa since the time of the early writers on the region, if these were to be trusted.

Mr. E. Wilkinson read a paper on the Kalahari desert, at the same meeting. It described a waggon drive through part of the desert area in company with two others, whose names were disguised under initials. Although great scarcity of surface-water was found, and the draught oxen and horses had sometimes to be watered from "sucking holes," where natives sucked up the water and filled the buckets from their mouths, the land was fairly well grassed in most parts, and Mr. Wilkinson believes it possible that it may subsequently become useful for grazing. A rough geological survey of the district passed over was made. Granite covered a large part of the surface, and appears to be the bed-rock of the whole district examined. Hard crystalline siliceo-calcareous beds and highly-altered ferruginous shales, as well as quartzite were also found, but vast accumulations of blown sand masked the true geological structure in almost every place.

The Geographical Society of California claims to have achieved "an immense success." The Society was incorporated on December 11, 1891, for "the acquisition and dissemination of scientific geographical knowledge," and has already achieved a membership of 400. Monthly lectures have been given, and a bulletin has been published. We hope that a society which has begun so well will fulfil the Latin proverb which it has adopted for its motto, "*Vires acquirit eundo.*"

THE ANNIVERSARY DINNER OF THE ROYAL SOCIETY.

The anniversary dinner of the Royal Society was held on the evening of St. Andrew's Day at the Hôtel Métropole. It was more largely attended than any previous anniversary dinner, covers being laid for about 230. The chair was occupied by the President, Lord Kelvin. On his right were Mr. Shaw-Lefevre, M.P., Sir James Paget, the Italian Ambassador, Prof. Raoult (medallist), Sir H. Roscoe, M.P., Sir James Lister, Lord Justice Lindley, Sir B. Samuelson, Sir A. Moncrieff, Sir U. Kay-Shuttleworth, M.P., Sir C. E. Bernard, the Dean of St. Paul's, Mr. John Hutton, and Sir H. Acland. On the left of the chair were Mr. Arthur Acland, M.P., Prof. Huxley, Mr. James Bryce, M.P., the Swedish Minister, Lord Ashbourne, Sir G. Stokes, the Treasurer of the Society (Sir John Evans), Mr. Alma Tadema, Sir R. E. Welby, Mr. Herbert Gardner, M.P., Sir Godfrey Lushington, Mr. Bryant, and Dr. Mackenzie. The vice-chairs were occupied by Sir B. Baker, Prof. Roberts-Austen, Lord Rayleigh, Prof. M. Foster, Sir A. Geikie, Mr. Norman Lockyer, Dr. Pye-Smith, Prof. Vines, and Mr. Rix (assistant secretary). The first toasts were "The Queen and the Prince and Princess of Wales," and "Her Majesty's Ministers and the Members of the Legislature."

Mr. Shaw-Lefevre, in the course of his reply to the latter, said that men of science as a rule were unwilling to abandon the quiet fields of research in order to launch on the stormy seas of politics; and if they were willing, they were too philosophical to swallow the creeds of either political party. He thought that the two older Universities might help in this matter, and do more to justify their right of representation by emulating the example of the London University in returning men of science to Parliament. If there was any man in the country whose presence in the House of Commons would add to its quality and power, it was Prof. Huxley.

Mr. Acland, in proposing the next toast, said,—I have to propose to those who are here present, and who do not bear the title of "F.R.S.," the toast of "The Royal Society"—a society ancient, independent, distinguished, and most beneficent in its operations during a course of more than two centuries. Why I, a mere politician, have been selected to propose this toast I do not know. In looking over a list of the late proceedings of your society a day or two ago, I tried to discover some links between yourselves and the Education Department, over which I preside. I came across the words, "On character and behaviour," and I thought that that looked like the kind of language which we employ in our instructions to her Majesty's inspectors of schools. But it was not so. The subject to which the words had reference was "on the character and behaviour of the wandering cells of the frog, especially in relation to micro-organisms." I feel that I must fall back upon some more substantial links than that, and I fall back upon the fact that I have the honour to preside over certain institutions in which members of your society are engaged. There is the Dean of the Royal College of Science at Kensington, Prof. Huxley; and your foreign secretary, Sir Archibald Geikie; and, altogether, including those who examine for us from time to time, there are something like thirty members of the Royal Society who are connected with those institutions, and I consider it a very high honour to be linked with institutions with which they are connected. Whether some of my friends at Kensington look on their connection with the State in the same light, I do not know. When I have the honour of going over the laboratories of my friends, Prof. Thorpe and Prof. Rücker, I am inclined to doubt it. But as far as the present connection with the State goes, the Royal Society do most admirable service. They act as unpaid judges for the administration of a sum of £4,000, which the State would find it very difficult to administer on its own account; and they do the work in so impartial and admirable a manner that no man in his senses could complain. There is one other link between us. There are present here a large number of men who are interested in the work of education; and I think they will agree with me that we have one great task before us. Between the Universities and the University Colleges with which most of them are connected and the great sphere of elementary education there lies a large region, at present unorganized and chaotic, which we want to organize and bring into working order as soon as possible. There are many men of science in these colleges who often greatly regret to find willing lads, with the highest scientific capacity, brought under their notice and care, whose only lack is a lack of adequate educational preparation for their work. It is that which we want to remedy, and if I am enabled to take however humble a share in remedying it, I shall be proud of the task. We want to engage in the task of the reclamation of waste; and one of the most serious of all wastes is the waste of intellect. For those lads who go to our colleges in every part of Great Britain and Ireland we want to hold out one great possible goal—the blue riband of science—the title of Fellow of the Royal Society. You at any rate in your scientific honours have no distinction of class, and, as your medallists to-day will testify, no distinction between one country and another. You regard all as equal when you adjudge your honours to the fittest men to bear them. I connect with this toast the name of your distinguished President, Lord Kelvin. It was truly said some nine years ago, when his claims were urged for the Copley Medal, "there is scarcely a branch of physical science to the substantive advantage of which he has not contributed"; and I understand that while he has touched both the highest and the most abstruse subjects, he has not failed to condescend even to humble matters like the domestic water-tap. Among those of you who know far better than I do what Lord Kelvin has done, both for abstruse science and for the welfare of mankind, there can be no limit as to the value of his work to future generations. I am sure that he himself cannot possibly say how great the value of what he has done may be in the far-off future. But I understand from Sir Archibald Geikie that your president has attempted to put a limit to the inquiries of the geologists, when they look into the backward past. He has definitely said that in looking backwards they must not go beyond the moderate limit of twenty million years. I understand that this is a grievance on the part of the geologists, but I hope that the President will not give unnecessary pain to his geological friends. In the draft of the preamble of your charter—it was drafted by Sir Christopher Wren—it was said Fellows of the Royal Society, by "their labours in the disquisition of nature, would try to prove themselves real benefactors of mankind." I give you the toast of "The Royal Society," coupled with the name of Lord Kelvin, and I assert that your present President has done his part in proving himself a benefactor of mankind.

The Chairman, in replying, said,—I thank you very heartily for the kind manner in which you have received this toast. I feel the honour you do me, but I also feel my incapacity to say

what ought to be said for so great an institution. I can only say in my own way that I believe the Royal Society, as an institution, has up to the present time persevered in well-doing, and had been successful in its efforts. The Royal Society has certainly endeavoured to carry out the objects of its institution—namely, to inquire into natural knowledge and the improvement of it. The mode of carrying out that object was carefully considered, no doubt, by those who founded the Royal Society; and they determined to hold regular meetings, partaking somewhat of the character of a debating society—meetings where discussions could be raised by questions presented, and the truth arrived at thereby. That object has been carried out from the inception of the Society to the present day; and the society has been imitated by other societies over a large part of the civilized world. Indeed, the Royal Society itself only followed in the path of other learned societies in Italy, which had determined that by personal discussion of questions in regular meetings truth might be arrived at which otherwise might be lost. We often find complaints that meetings of scientific societies are unsatisfactory. We have even complaints that the important duty, the publication of their proceedings for the rest of the world, is not altogether ideally perfect. Some who desire the progress of science above all, and heartily wish success to the Royal Society, think that the society ought to be a body for merely recording and indexing the work that has been done all over the world. That is a part of the work of the Royal Society which is not neglected. The council has had most anxious, careful, and laborious consultations from year to year with reference to this work—not only as to the publication of its own transactions and proceedings, but as to the cataloguing and indexing of the proceedings of scientific bodies and scientific workers all over the world. One very important part of the work of the society consists of the cataloguing of all scientific papers published; and a very dry and fatiguing subject it is to work upon. The difficulty here is *embarras de richesses*. To get the titles only of these papers is itself a truly Herculean task. If the Royal Society had not only capacity, but had also great funds at its disposal, it would make short work of this task. It would not only index, it would publish the papers: and would put them in such a form that any one could find his own particular subject at once, and the particular volume and page in which it was treated. This is an exceedingly difficult subject, but the first necessity is funds, and if those were supplied all the rest would follow. The publishing and indexing, however, is not the only work of the society. The life and soul of its work is in its meetings and discussions, and whoever has not felt the stimulus of attending those meetings has hardly yet found out the spirit of scientific enquiry. For myself, I say the fact that we can attend meetings of the Royal Society, and hear papers on subjects very far removed from the subjects of our every-day work, is a stimulus which is of the highest value. The worker who has heard what other people are doing goes back to his work with something which may help him in it, which, at any rate, brightens his life, and makes the drudgery and heavy work necessary for success in any scientific investigation less irksome and dry. For myself I may say that my connexion with the Royal Society, extending over a great many years, has been one of unmixed benefit and pleasure, and has given to me some of the happiest of those pictures of knowledge and memory the possession of which constitutes so much of the delight of life. Mr. Acland remarked upon my having been hard upon the geologists. I do not think that I have actually been so. I do not believe in one science for the mathematician, another for the chemist, another for the physicist, and another for the geologist. All science is one science; and any part of science which places itself outside the pale of the other sciences ceases for the time being to be a science. The sooner it returns to the pale of the other sciences the better; and when all are working for a common good the better it will be for the progress of each.

Prof. Huxley, in proposing the next toast, said that he had to discourse on the merits of the gentlemen to whom medals had been awarded. There was one the adequate treatment of whose merits would occupy the whole available time; and yet Mr. Shaw-Lefevre wished him to say something about his capacity to become a legislator and also to give an opinion upon geological time. He would answer the first interrogation by telling a story. When he was a very young man a solicitor in large practice discovered in him what that gentleman believed qualities that would command success at the Bar, which he had never discovered himself, and proposed to advance him an income for a certain number of years until he could pay the amount back out of the fees he was sure to earn. He was sorry to say his reply was this, "So far as I understand myself, my faculties are so entirely confined to the discovery of truth that I have no sort of power of obscuring it." With regard to political life, the absolute contradictions that were made by politicians of opposite sides upon matters of fact were absolutely fatal to his chances in a political career. Coming to the subject of the toast, he narrated the history of the Copley medal. A bequest of £100 was left to the Society 188 years ago by Godfrey Copley, a Fellow of the Society, for improving natural knowledge. The medal was thrown open to all the world, a step much disapproved by certain narrow-minded persons at the time; but that step was the real reason why, a century later, Sir Humphry Davy could really call it "the ancient olive crown of the society." The value of the medal was originally fixed at £5, people being able to get five per cent. for their money in those halcyon days. He did not like to dwell upon its appreciation now lest the County Council should put in a claim for unearned increment. The medal had certainly done nothing for itself; the appreciation of its value had arisen entirely from surrounding circumstances, the chief being the wisdom and integrity of some eighty successive councils. A complete list of the awards was published every year. Going back one hundred years from 1887—he had a reason for not taking a later date—the century began with John Hunter, and finished with Joseph Hooker. Between them was a galaxy of the heroes of science, French, German, Scandinavian, Italian, American, and English; and, although one star might differ from another star in glory, none was unworthy of its place in the constellation. The present council had not fallen below the standard of its predecessors; there was no biologist, no scientific physician, no anthropologist, no archæologist to whom the name of the illustrious Rector of the University of Berlin, Rudolph Virchow, was not familiar. No one had done more to put pathology on a scientific foundation; no one had done more for critical anthropology, especially in connection with archæology. Without venturing on the dangerous field of politics, he would add that these merits were, to his mind, greatly enhanced by the fact that Virchow had never merged the citizen in the philosopher, but amidst great difficulties and with undaunted courage, he had taken an active, a disinterested, and a thoroughly independent course in the Legislature of his country. The next medal in order of age was that founded by Count Rumford at the commencement of this century, on equally cosmopolitan principles, but limited in scope to the physico-chemical sciences. In these sciences hardly anything had attracted popular attention more of recent years than the marvellous power which spectroscopy had placed in our hands to discern the chemical composition of bodies which were millions and billions of miles away; and, for anything we knew to the contrary, these minute and careful inquiries into the constitution of stars might be *post-mortem* examinations. In the accurate examination of stars by the spectroscope, he understood from others that Dr. Dunér, of Sweden, had laid secure foundations for all future investigations. The Royal medals were founded by the Sovereign some sixty-odd years ago, were now maintained by her Majesty, and were confined to British subjects. There were two medals every year, and they were usually allotted one to physical and chemical science, and the other to biological science. They were usually given to younger men; and it was so in his own case forty years ago. The value of the medal was inexpressible to him. In his younger days, if a man took to science, it was thought he was going to the bad. The receipt of the medal made an entire revolution in the minds of his friends; and he was a respectable person from that time. On the present occasion the first of these medals was awarded to the present Director of the Astronomical Observatory in Oxford, Prof. Pritchard, and he was told that there was no observatory in the three kingdoms in which so much admirable work of observation was being done. Only a short time ago the Royal Astronomical Society awarded its gold medal to the Director of the Oxford Observatory. He was further told that the director was tackling what he understood was one of the most difficult pieces of astronomical work—parallax determination; and that he had already printed off more stars than anybody else. Besides this, he was hard at work on the great international chart of the heavens. It was obvious that this gentleman must be in the

full vigour of youthful energy, and therefore he treated with contempt a rumour that had reached him that the director was in his eighty-fourth year. They would join with him in wishing Prof. Pritchard a long continuance of the health and strength which were turned to such splendid account. The second of these medals was awarded to Dr. Langley, of the University of Cambridge, for the long-continued and very valuable physiological researches. There was a familiar phenomenon observable before sitting down to dinner, and known as watering of the mouth. If it were possible to determine the exact condition of that operation in physiology the exact knowledge would be a key to an immense range of the secrets of Nature. It was these problems that Dr. Langley had been investigating, and he had come nearer to their solution than any one else. The Davy medal was awarded to a distinguished French *savant*, M. Raoult, whose work was considered of the highest importance; and he rejoiced that the recipient of the medal was present. The Darwin medal was instituted in honour of one of his best and dearest friends, and it was now conferred upon a man who was one of the stanchest friends he had had for the last forty years. He might fairly appeal to Sir Joseph Hooker's present activity, put him down also among the young men, and thereby save the credit of the council in the matter of its own regulation. To those who knew the "Life and Letters of Darwin," talk about Sir Joseph Hooker's right to the Darwin medal was as futile as the attempt to judge Manlius in sight of the Capitol. He knew no more remarkable example of life-long devotion, of stores of information laid open, of useful criticism, and of still more useful encouragement, by one man to another, than that exhibited by Sir Joseph Hooker in this picture. It might be that even the man whose motto was "It's dogged as does it," and who so patiently laboured for half a lifetime at the great fabric of the origin of species, might have fainted by the way without this friend's aid. And assuredly Hooker's great study of geographical distribution was a most important factor in Darwin's work. It lay in the eternal fitness of things that Wallace and Hooker should receive the Darwin medal; and that these old young-men should give it a heightened value for the young young-men to whom it would hereafter pass.

Prof. Raoult returned thanks, speaking in French.

Dr. Langley responded for the other medallists and himself.

Sir James Paget briefly proposed "The Guests."

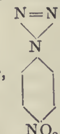
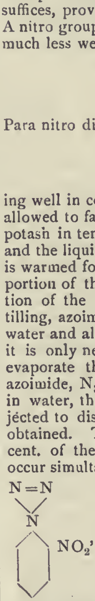
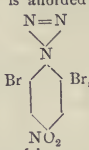
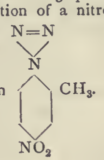
The Swedish Minister, in responding, said—The honour to be your guest and to participate with you in the celebration of this interesting day cannot be more thankfully felt than by me, who still has to consider this favour, above all, as a compliment to the country where you have selected this year your Rumford medallist. This distinction to my fellow-countryman, Prof. Dunér, whose merits Prof. Huxley has so eloquently explained to you, is a new link in the long chain of tokens of sympathy and appreciation from this society to scientific Scandinavians, a chain of which one of the oldest links is the creation of the Linnean Society. More than a hundred years have passed since, and in the meantime many systems have been altered; and, especially in the last twenty years, those alterations have so closely followed the one upon the other that we laymen have been accustomed to believe we were entitled to ask every new morning, "What great discovery will this day bring?" In one department, however, scientific men as well as laymen cannot admit the possibility of any alteration, and that is in our conviction and belief that this country occupies a prominent place in the universal scientific movement—a proof of which, among many others, is the fact that no other institution in the world encourages as much as does this society other countries' scientific researches.

Mr. Alma-Tadema also responded, remarking in the course of his speech that there was no art without science, neither was there any science without art: and that art coloured life as the sun colours the flowers of nature.

AZOIMIDE.

A FURTHER communication concerning azoimide, the interesting compound of hydrogen and nitrogen, N_3H, discovered two years ago by Prof. Curtius, is contributed to the current number of the *Berichte* by Drs. Noelting and Grandmougin of Mülhausen, in conjunction with Herr O. Michel. As described in our note of vol. xliv. p. 600, Drs. Noelting and Grandmougin have previously shown that azoimide may be obtained by indirect means from the singular compound prepared somewhere about the year 1866 by the late Dr. Peter Griess, and which has hitherto been known as diazobenzene imide, $C_6H_5—N\langle{}^{N}_{N}\|$. This compound is now recognised as the phenyl ester of azoimide. It is, however, a substance of very considerable stability, and successfully resists the attack of concentrated alcoholic potash, even under pressure. Although thus stoutly resisting direct attack, Drs. Noelting and Grandmougin have shown that by undermining its constitution by the introduction of a couple of nitro groups in the place of two hydrogen atoms, it becomes weakened so greatly as to be no longer capable of withstanding the action of the alkali, and is decomposed with production of the potassium salts of azoimide and dinitro-phenol—

$$C_6H_3(NO_2)_2N_3 + 2KOH = C_6H_3(NO_2)_2OK + N_3K + H_2O.$$

This interesting result is now supplemented by showing that it is not necessary to introduce *two* nitro groups in order to render diazobenzene imide sufficiently negative in character as to be susceptible to the attack of alcoholic potash, that *one* such group suffices, provided it be introduced in the para or ortho position. A nitro group introduced in the meta position appears to exert much less weakening power, quite inadequate for the purpose. Para nitro diazobenzene imide, , is a substance crystallizing well in colourless tabular crystals. When these crystals are allowed to fall slowly into a cold solution of one part of caustic potash in ten parts of absolute alcohol, they instantly dissolve and the liquid becomes coloured a deep red. If this red solution is warmed for a couple of days over a water bath, and the larger portion of the alcohol subsequently distilled off, upon acidification of the residue with dilute sulphuric acid, and again distilling, azoimide, N_3H, passes over along with the vapours of water and alcohol. In order to free the azoimide from alcohol it is only necessary to neutralize the distillate with soda, and evaporate the solution to dryness, when the sodium salt of azoimide, N_3Na, is obtained; the sodium salt is then dissolved in water, the solution acidified with sulphuric acid, and subjected to distillation, when an aqueous solution of azoimide is obtained. The yield of azoimide is usually only about 40 per cent. of the theoretical, owing to secondary reactions which occur simultaneously with the main one. The ortho compound, , treated in a similar manner, also furnishes azoimide to the extent of about 30 per cent. A very much larger yield, about 85 per cent., is afforded by the dibrom derivative of the para compound, , a substance which is readily obtained in the form of long colourless prisms. Azoimide has also been obtained to the extent of 30 per cent. of the theoretical amount by the decomposition of a nitro toluene derivative of azoimide of the constitution .

THE NEW STAR IN THE CONSTELLATION OF AURIGA.[1]

THE appearances which the new star has presented were exceedingly remarkable, and observations, both spectroscopic and photometric, were far more numerous than have been obtained during former occurrences of this kind. The latter have been sufficient to establish the unsuitability of several explanations which have been suggested with regard to former new stars, suggestions which at the time appeared more or less plausible. On the other hand, however, it is very difficult to establish, from the publications of observers up to the present time, all details required for a general proof of a definite hypothesis. It appears to me appropriate to suggest a new attempt at explanation, which seems to tally better than others with the principal results of observation, the final tests of which hypothesis must, however, for the present remain a matter for the future. But if this attempt should in the present instance meet with difficulties—a case which I admit to be possible, if not probable—it yet deserves a somewhat more detailed explanation, because it thoroughly takes account of, as I believe, possible conditions, and therefore certainly contains a possible hypothesis with regard to the appearances of certain new stars. In the following remarks I shall strictly adhere to the facts which are to be considered, according to the statements of the observers, as the result of their observations, whereas a proof of the latter is beyond the limit of this article. I may here mention that I have already suggested the most essential of the following remarks in March of the present year.[2]

The chief results of observations, which may be said to contain the characteristics of all the appearances, are:—

1. According to Herrn Lindeman[3] the light-curve of the Nova presented the following appearances:—

"From February 1 to 3 the photometric curve rises quickly to a brightness of 4.7m., then gradually sinks till February 13, and then quicker until February 16 to 5.8m., reaches a second maximum of 5.14m. on February 18, has a second minimum on February 23, likewise of 5.8m., and then a third maximum on March 2 again of 5.4m., upon which it sinks till March 6, slowly at first, and then quicker, in a straight line till March 22 down to 9.3''. I may here add that from the photographs taken at Harvard College, it was possible to show that the star became visible from the beginning of December, 1891, that already in the period of time December 20–22 it showed a maximum of brightness which reached almost, but apparently not entirely, a maximum on February 3.

2. The spectrum of the Nova was most remarkable. Prof. Vogel, in summing up the results obtained at Potsdam,[4] writes:—

"The observations have led to the exceedingly interesting result that the spectrum of the Nova consists of two superposed spectra, and that a number of lines, especially those of hydrogen, which appear bright in one spectrum and dark in the other, are closely adjacent to one another. This fact admits of hardly any other explanation than the presence of two bodies, the component motions of which in the line of sight are very considerable. . . . The bodies separate from one another with a relative velocity which during four weeks' observations (in February) suffered no appreciable change, and which amounted to at least 120 miles per second." It may be further added[5] that among the very broadened bright lines there were noted several intensity maxima, two being especially striking.

It has been suggested as an explanation of the facts of observation that two heavenly bodies have passed very close by one another, and that thus changes in their atmospheres have arisen which have caused the sudden brightening up of the bodies. The above hypothesis is, however, in this form too vague to be followed in detail. In reverting to an idea of Klinkerfues, it is true that a more distinct picture of the whole occurrence has been drawn, by assuming tidal effects of the two bodies upon each other: in this manner where the tidal crests of the atmosphere appear, there the darkenings take place by absorption, and where the ebb predominates a brightening is the result, because here the absorbing strata of the atmospheres are less powerful. It must be mentioned, however, that the statical theory of Ebb and Flow that has been applied is altogether inappropriate to give an idea of the deformations which doubtlessly occur at such a near proximity. The effect of the two heavenly bodies on each other in Nova Aurigæ, as is still to be shown, would have to be one that is almost always suddenly appearing and immediately afterwards vanishing. Moreover it must not be overlooked, that with incandescent bodies their atmospheres must be regarded as outward shells which quite gradually emerge into denser strata, while these also are deformed in a lesser degree. In other respects, too, it will be difficult to explain the appearances of a new star as a consequence only of the effects of absorption of atmospheres. It has also been assumed for the most part that besides these (absorptions), eruptions of gas from the centre of the body take place. This assumption, it is true, contains nothing impossible, but without a definite form it hardly admits of discussion. At all events it will be necessary to suggest further hypotheses in order to apply this attempt at explanation to single cases. Moreover, it remains yet unexplained why in Nova Aurigæ the one spectrum is chiefly an absorption spectrum and the other a gas spectrum. By special assumptions this difficulty can be certainly eliminated, but it is not very probable that on this account confidence can be placed in the correctness of the hypothesis.

Other facts appear, however, in the case of Nova Aurigæ which do not speak in favour of this hypothesis, however generally it may be expressed. It is at least very striking that just in this case such enormously great velocities of cosmical bodies appear, such as have hitherto not been found anywhere else. The occurrences of these velocities must therefore be numbered among the facts to be explained. Further on formulæ will be given from which, at least to a certain degree, the mechanical conditions of the close approach of two bodies can be computed. From this it follows that in the case of Nova Aurigæ the two bodies can describe a parabola round each other only if their masses are much larger than 15,000 times the sun's mass. For a hyperbolic movement one can obtain an essentially smaller value of the mass, by assuming that the enormous relative velocity of 120 miles observed has been produced to a small degree by attraction and has existed almost entirely from the beginning. Thus the choice is left between the assumption of extremely large masses or the giving up of an explanation of the great relative velocity. Neither of these two assumptions contain, it is true, an impossibility, but I do not think that doubtful proofs for the correction of the hypothesis can be noticed in either of them. According to my opinion they rather render it (the hypothesis) very little plausible.

The formulæ already mentioned indicate what will be explained further on, namely, that the supposed effect of the two bodies, in the case in hand, must have taken place very quickly indeed, perhaps even in the period of a few hours. This effect must necessarily have occurred upon the first brightening up (beginning of December 1891). Why then the Nova attained several weeks later (beginning of February 1892) a second maximum, and to all appearances a greater maximum, and why the light-curve sank only very little till the beginning of March but afterwards very rapidly, seems to me, on the ground of the hypothesis in question, to be explainable only with great difficulty, if it can be explained at all. At all events, this difficulty will remain unless it be altogether removed in detail.

The difficulties hinted at above entirely disappear in the following supposition. There is no doubt, especially in accordance and with the results obtained from stellar photographs, in which Mr. Max Wolf has co-operated, that space is entirely filled with more or less extensive formations of very thinly scattered matter. With regard to their physical properties, these formations will probably show very varied constitutions, the reason for which we will leave an open question, as we do not wish to investigate it here. It is itself not very improbable that a heavenly body should get into such a cloud, but in any case it is more probable than the grazing together of two compact bodies, as is required in the above-discussed hypothesis. As soon now as the body commences to enter a cosmic cloud a surface heating will be set up at once, and indeed it must be so, whatever may be the constitution of the thinly-scattered matter. In consequence of this heating, the products of vapourizaation will form round the body; these will partly be separated

[1] Translation of an article by H. Seelinger, in *Astronomische Nachrichten* (No. 3118),.
[2] "On a General Problem of the Mechanics of the Heavens," p. 23. (München, 1892.)
[3] *Astr. Nach.*, No. 3094.
[4] *Vierteljahrsschrift der Astr. Gesellsch.*, Band 27, p. 141.
[5] *Astr. Nachr.*, 3079, p. 110.

from it and will adopt very quickly that velocity which the adjacent parts of the cloud possess.

It is interesting to compare this process with a similar one, which takes place in a well-known way in the appearance of shooting stars or fireballs. In this case a compact body enters with a certain velocity into a formation of very thin matter (the upper strata of the atmosphere), is heated and partly vapourized, and a luminous tail, which is clearly visible for a long time after the sudden appearance of the meteor, marks the path which the latter has taken. The detached particles have quickly lost their relative velocities against the air, for they apparently do not partake of the movement of the meteor.

If we consider spectroscopically the star on its commencement to become bright by resistance, two superposed spectra will openly reveal themselves, one in general continuous and provided with absorption bands in consequence of the heaping up of the glowing gases, and the other in the main consisting of bright lines. Both spectra, according to the relative motion in the line of sight, will appear pressed up against one another. Thus altogether an appearance is found very similar to that observed in Nova Aurigæ, and they will agree entirely if one assumes that also those parts of the cloud nearest the body have sustained physical perturbations by a direct frictional warming of the detached particles, &c. This assumption seems to me to contain by no means a difficulty considering our lack of knowledge with respect to the properties of this cloud matter. Whether this is at all necessary I am unable to say on the ground of the publications at hand.

The investigation is important to decide whether, on the lines laid out, we can obtain a plausible explanation of the great relative velocities shown by the two spectra. When the body approaches the cloud the latter will evidently lengthen itself in the direction of the former. This lengthening will grow with the mutual approach, just as the relative velocity of the single parts of the cloud will grow towards the body. Without certain suppositions on the structure of cloud matter it is difficult to conceive of the processes of movement which take place, so we must content ourselves with contemplating the one or the other case, which admits of a closer investigation.

If, for instance, we suppose that the single particles of the cloud follow for the main part the effect of the body, they will describe conic-sections—that is, hyperbolas round the centre of the latter as forces. Their greatest relative velocity decreases quickly with the distance of the body, so that the surroundings of the latter will be filled with particles moving with very different velocities. One can easily see that no very extraordinary assumptions are necessary to suppose very great velocities for these particles that pass near the surface of the body, velocities amounting to those stated in the case of Nova Aurigæ, even if they are at the outset very small. It follows from the above that the spectral-lines of the particles which are moving from the body with such different velocities must be very much enlarged, and that to explain the different brightenings of the single parts of the lines as probably intensity maxima does not raise the least difficulty, but is a necessary accompanying phenomenon. This point seems to me to be important, for it cannot be deduced from the hypothesis of two compact masses passing close by one another, and must here lead to the rather improbable assumption of several moving bodies.

As long as the body remains in this, so to speak, atmospheric formation, the appearances above mentioned must always be called forth anew, whence it follows that the peculiarities of the spectrum conditioned by the whole state of things, not considering smaller perturbations, must on the whole remain constant for some time, a point which in the above hypothesis is at first not by any means clear. In a similar manner it will not be astonishing if the star during that time changes its brightness less strongly, while after its exit from the cloud this brightness will decrease rather rapidly. This too agrees with the light-curve in the case of the Nova. Finally, even the periodical fluctuations of the magnitude can be explained quite naturally. We call to mind here the well-known fact confirmed lately by the photographs of Max Wolf, that similar occurrences appear in shooting stars, which may, indeed, be explained with difficulty.

We must, however, in any case assume that the star entered the cosmical cloud in question about the beginning of December and left it not long before the beginning of March. Now the question is urged upon us How was it possible that for such a long time the great relative velocity could remain constant though such a resistance must have taken place that could develope the heat necessary for the glowing of the body? We are here going to decide this question by comparing the resisting power of the star to that of a meteor in the upper strata of our atmosphere.

Let us assume, quite generally, that the motion of the star in a straight line is given by the equation

$$\frac{dv}{at} = -lv_n \quad \ldots \ldots \ldots \ldots \quad 1)$$

(1) where v is the velocity, n a positive number $>$ 1 and λ a constant, which is directly proportional to the surface of the globular body and the density of the medium and inversely proportional to the mass of the body. We compare equation (1) with the equation for the motion of a meteor

$$\frac{dv'}{dt'} = -\lambda' v'^n$$

in which the time t' is referred to another unit selected for the purpose. If we suppose $v' = \mu v$; $t' = \nu t$; $\lambda = \lambda \nu\mu^{n-1}$. The latter equation becomes identical with (1), that is the movement of the star corresponds point to point with the motion of the meteor, if the latter equations are satisfied. Representing now m, O, r, δ, m', O$'$, r', δ', as masses, surfaces, radii, and densities of the star and meteor, and D and D$'$ the density of the cosmical clouds and the upper strata of the atmosphere in question, we have:—

$$\frac{\lambda}{\lambda'} = \frac{DOm'}{D'O'm}; \ \nu \quad \frac{1}{\mu^{n-1}} \cdot \frac{DOm'}{D'O'm}.$$

or also

$$\nu = \frac{t'}{t} = \left(\frac{v}{v'}\right)^{n-} \frac{r'\delta' D}{r\delta D'}.$$

If we put $r = k$ times the sun's radius ($=$700 million metres) and $r = r'$ metres, and further corresponding to the observations of the new star $v = 30$ (unit of velocity of Earth in its orbit) and $t = 100$ days and $v' = 2$ which corresponds to a relatively quickly-moving meteor and finally $n = 2$, we have:—

$$\nu = \frac{15}{k} \cdot \frac{D\delta'}{D'\delta} \cdot \frac{r'}{700 \text{ millions}}$$

$$\text{and } t' = 0^s.185f; \ f = \frac{r'\delta' D}{k\delta D'}.$$

Thus the movement of the star takes place proportionally in 100 days, just as that of the meteor in 0·185 seconds if we suppose $f = 1$. As we are free to assume $\frac{D}{D'}$, small, we can obtain a very small fraction of a second, and since within a hundredth part of a second the movement in the highest regions of our atmosphere shows no longer a perceptible decrease of velocity, such a decrease will not enter in the case of the star. We have evidently to deal here with the same appearance which points out that small heavy objects possess a far greater resistance to air than large ones, and that with large meteors (fireballs) the air resistance, as it has been proved, influences the elements of the orbit far less than is the case with small meteors.

We have still to show that in spite of the small decrease of movement, enough energy of movement is changed into heat in order to bring the star into a surface-glowing condition, and such a condition has by all means taken place in the Nova. We must therefore calcuiate the quantities of heat Q and Q$'$ which is radiated in one second of time, and from a unit of surface on both bodies. If we call P and P$'$ the losses in acting power during the times t and t', v_0 and v_0' the velocities before the entrance into the resisting media, we have:—

$$Q = \frac{P}{Ot}; \ Q' = \frac{P'}{O't'}$$

$$\text{and } P = m(v_0^2 - v^2); \ P = m'(v_0'^2 - v'^2)$$

and taking into consideration the above equations:

$$\frac{Q}{Q} = \frac{D}{D'}\left(\frac{v}{v'}\right)^{n+1}$$

with the above numbers $\frac{v}{v'} = 15$; n will be $= 2$

$$\frac{Q}{Q'} = 3375 \cdot \frac{D}{D'}$$

so that we can assume that the density of the cosmic medium, compared to these already very thin air strata, in which evidently

the glowing of the meteor occurs, is not very dense, and that one yet gets the necessary quantity of heat.

It may be remarked that we can vary all these numbers within very wide limits without fearing any contradiction, so that we may conclude, therefore, that no difficulty in the suggested hypothesis arises from this point of view.

I have now to deduce the formulæ I have mentioned above, and it will be seen that these are very interesting.

If we take μ as the sum of two masses revolving round each other in a conic section, V the velocity, and retaining for the rest the customary nomenclature, we have for the parabola

$$V^2 = k^2\mu \cdot \frac{2}{r}; \quad r = \frac{q}{\cos^2 {}^1/_2\, v};$$

$$\tan \tfrac{1}{2} v + {}^1/_3 \tan^3 {}^1/_2\, v = \frac{k\sqrt{\mu}\, t}{q^{3/2} \sqrt{2}}.$$

Whence it follows without further difficulty:

$$\mu = \frac{V^3 t}{4k^2 \sin {}^1/_2\, v \,[1 - {}^2/_3 \sin^2 {}^1/_2\, v]}.$$

One takes c as the velocity of the earth in its orbit with the radius R and puts the sun's mass and the mass of the earth $= 1$, so that $k^2 = c^2 R$. If we consider further that the expression

$$\sin {}^1/_2\, v\, [1 - {}^2/_3 \sin^2 {}^1/_2\, v]$$

can attain the maximum value $\frac{\sqrt{2}}{3}$ it follows that

$$\mu > \frac{3}{4\sqrt{2}} \cdot \left(\frac{V}{c}\right)^3 \cdot \frac{ct}{R}.$$

or if c be given in solar days

$$\mu > 0{\cdot}009123 \left(\frac{V}{c}\right)^3 t. \quad \ldots \ldots \quad (4)$$

To apply this to the Nova we must remember that $\frac{V}{c} > 15$ because the orbital velocity may be greater than that in the line of sight. Besides, more than two months have passed since the supposed grazing of the bodies took place, which time must coincide closely with that of perihelion, up to the time that we have still spectrum observations in hand. Thus t is much greater than 60. Formula (4)—

$$\mu > 14779 \times \text{sun's mass}$$

gives thus a limit which supposes masses far too small. In reality we might perhaps assume double this without challenging contradiction.

The consideration of a hyperbolic movement takes a similar though less simple form.

If V_0 represents the velocity at an infinitely large distance, we have

$$V^2 - V_0^2 = \frac{2k^2\mu}{r},$$

and according to the Theoria Motus—

$$\frac{r}{a} = \frac{e - \cos F}{\cos F},$$

$$e \tan F - \log \tan (45^\circ + 1/2\, F) = \frac{k\sqrt{\mu}\,.\,t}{a^{3/2}},$$

from which it is found at once that—

$$\left.\begin{aligned} \mu &= \left(1 - \frac{V_0^2}{V^2}\right)^{3/2} \left(\frac{V}{c\sqrt{2}}\right)^3 \frac{cA}{R} X \\ X &= \left(\frac{e - \cos F}{\cos F}\right)^{3/2} \cdot \frac{1}{e \tan F - \log \tan (45^\circ + 1/2\, F)} \end{aligned}\right\} (5)$$

The expression for X, if one allows F to vary from 0°–90°, first decreases, reaches a minimum, and then increases to infinity. The minimum value can easily be determined for then

$$\frac{3}{4}\,\frac{e \sin 2F}{(e - \cos F)^2}\,[e \tan F - \log \tan (45^\circ + 1/2\, F)] \text{ must be } = 1.$$

This equation can be easily solved for special values of e. For the theoretical calculation which is requisite, I have employed another proceeding, as I have already computed the serial values of X for a special value of e, as the following table shows:—

	$e = 1{\cdot}5$	2·0	4·0	6·0	8·0	10·0
F = 4	10·207	14·393	24·882	32·111	37·988	43·071
8	5·224	7·302	12·554	16·182	19·135	21·689
12	3·614	4·987	8·494	10·930	12·913	14·630
16	2·852	3·866	6·505	8·348	9·853	11·156
20	2·429	3·226	5·345	6·838	8·059	9·118
24	2·178	2·827	4·603	5·806	6·902	7·802
28	2·027	2·569	4·343	5·204	6·112	6·902
32	1·941	2·400	3·753	4·740	5·555	6·265
36	1·900	2·293	3·510	4·411	5·158	5·810
40	1·892	2·234	3·345	4·181	4·877	5·486
44	1·911	2·211	3·240	4·029	4·688	5·266
48	1·953	2·220	3·187	3·941	4·574	5·131
52	2·017	2·257	3·179	3·911	4·528	5·072
56	2·101	2·323	3·217	3·936	4·547	5·086
60	2·208	2·420	3·301	4·020	4·633	5·175
64	2·341	2·552	3·438	4·170	4·797	5·351
68	2·510	2·729	3·644	4·404	5·056	5·635
72	2·728	2·968	3·944	4·754	5·451	6·070
76	3·026	3·307	4·390	5·286	6·055	6·739
80	3·477	3·830	5·108	6·152	7·048	7·843
84	4·308	4·802	0·480	7·824	8·972	9·991
88	6·991	7·938	10·960	13·320	15·321	17·091

For very large values of e the minimum of X occurs if

$$\sin F = \sqrt{2/3},$$

and the minimum value of X becomes

$$\text{Min } X = \sqrt{\frac{3^{3/2} \cdot e}{2}} = 1{\cdot}612\sqrt{e} \quad \ldots \ldots \quad (6)$$

But one practically commits no error if one employs (6) also for the values of e nearly equal to 1, as is evident from the following computation of the minima values taken from the above table, and calculated according to formula (6).

e	Direct.	Formula.
1	1·5	1·6
1·5	1·9	2·0
2	2·2	2·3
4	3·2	3·2
6	3·9	3·9
8	4·5	4·6
10	5·1	5·1

One obtains:—

$$\mu > 0{\cdot}0104 \left(1 - \frac{V_0^2}{V^2}\right)^{3/2} \left(\frac{V}{c}\right)^3 \sqrt{e}\,.\,t \quad \ldots \quad (7)$$

For the above assumptions—

$$t = 60, \left(\frac{V}{c}\right) = 30,$$

we find

$$\mu > 16800\sqrt{e}\left(1 - \frac{V_0^2}{V^2}\right)^{3/2}$$

which formula holds good for values of e, which do not quite equal 1. In order to include also the parabola we suppose

$$\mu > 15000\sqrt{e}\left(\frac{V^2 - V_0^2}{V^2}\right)^{3/2} \quad \ldots \ldots \quad (7a)$$

Thus in this case we result in extremely large masses, which are not very probable, or we must assume that $\frac{V_0}{V}$ = very nearly 1. Even for $\frac{V_0}{V} = 0{\cdot}9$, according to the above formula, $\mu > 1200\sqrt{e}$, and we may consider the above-given assertion as justified. It has already been remarked that this suggested inequality proves only that μ is very much greater than the right side (of the equation).

It is easy to find a higher limit for μ if $\frac{V_0}{V}$ does not differ much from unity.

If we put $\frac{V^2 - V_0^2}{V^2 + V_0^2} = \nu$, we obtain $\cos F = \nu e$, and according to formula (5):

$$\mu = \left(\frac{1 - \nu}{1 + \nu}\right)^{3/2} \left(\frac{V}{c}\right)^3 \frac{ct}{R} \cdot \frac{\nu}{e\nu \tan F - \nu \log \tan (45^\circ + 1/2\, F)}.$$

Given t, e, and v, we can calculate the right-hand side. But we seek, however, the maximum value of

$y = ev \tan F - \nu \log \tan (45^\circ + 1/2F) = \sin F - \nu \log \tan (45^\circ + 1/2F)$

by determining e as function of ν. It is

$$\frac{\partial y}{\partial e} = \left(\cos F - \frac{\nu}{\cos F}\right)\frac{\partial F}{\partial e} = \frac{\nu(1 - \nu e^2)}{e\sqrt{1 - \nu^2 e^2}}.$$

Thus y increases so long as $e < \frac{1}{\sqrt{\nu}}$, and decreases continually for $e > \frac{1}{\sqrt{\nu}}$. The maximum for y takes place when $e^2 = \frac{1}{\nu}$, and is

$$y = \sqrt{1 - \nu} - \nu \log\left(\frac{1 + \sqrt{1 - \nu}}{\sqrt{\nu}}\right).$$

Thus we have

$$\mu > \frac{ct}{R}\left(\frac{V}{c}\right)\left(\frac{1 - \nu}{1 + \nu}\right)^{3/2} \cdot \frac{\nu}{\sqrt{1 - \nu} - \nu \log\left(\frac{1 + \sqrt{1 - \nu}}{\sqrt{\nu}}\right)}; \quad . \ (8)$$

and with $\frac{V}{c} = 30$ and $t = 60$ days,

$$\mu > 27800\left(\frac{1 - \nu}{1 + \nu}\right)^{3/2} \frac{v}{\sqrt{1 - \nu} - \nu \log\left(\frac{1 + \sqrt{1 - \nu}}{\sqrt{\nu}}\right)}.$$

For the above example $\frac{V_0}{V} = 0 \cdot 9$ results $\mu > 2800$ as considerably larger masses than formerly.

I have now further to prove that a very close proximity of the two bodies can have only taken place for a very short space of time. To do this we use the following relations.

We find above for the parabola:

$$\mu = \frac{V^3 t}{4k^2 x}; \ x = \sin \tfrac{1}{2}v(1 - 2/3 \sin^2 1/2v).$$

It follows, therefore, that

$$V^2 = \frac{2k^2\mu}{\nu}$$

$$r = \frac{Vt}{2x}.$$

Thus we have

$$v > \frac{3}{2\sqrt{2}}. \quad Vt = 1 \,.\, 06Vt \quad . \ . \ . \ . \ . \ . \ (9)$$

For the hyperbola we have

$$r = \frac{2k^2\mu}{V^2 - V_0^2},$$

and, according to formula (5)

$$2k^2\mu = \frac{(V^2 - V_0^2)^{3/2}}{\sqrt{2}} tX.$$

Therefore,

$$r = \frac{\sqrt{V^2 - V_0^2}}{\sqrt{2}} tX.$$

For eccentricities which are not very nearly equal to 1, we had

$$X > \frac{3^{3/4}}{\sqrt{2}}. \quad \sqrt{e},$$

and it is certainly

$$r > \frac{3^{3/4}}{2} \sqrt{e} \sqrt{V^2 - V_0^2} \,.\, t > 1 \cdot 06 \sqrt{V^2 - V_0^2} t \quad . \ (10)$$

For $V_0 = 0$.

(10) is naturally changed into (9). For the hyperbola, however, it is possible to suggest a second relationship.

Since

$$2\frac{a}{r} = \frac{V^2 - V_0^2}{V_0^2}.$$

(5) can also be written

$$k^2\mu = \left(\frac{a}{r}\right)^{3/2} V_0^3 tX.$$

and because $k^2\mu = aV_0^2$, it follows that

$$r = \sqrt{\frac{a}{r}} \,.\, V_0 tX = V\,ty,$$

where

$$y = \frac{e - \cos F}{\cos F} \cdot \frac{1}{e \tan F - \log \tan (45^\circ + 1/2F)}.$$

An easy calculation yields now

$$\frac{\partial y}{\partial F} = \frac{-1}{e \sin F - \cos F \log \tan (45^\circ + 1/2F)} \cdot [(1 + e^2) \cos F - 2e + e \sin F \log \tan(45^\circ + 1/2 F)].$$

It is quite evident that the quantities in brackets always remain positive, for it is

$\log \tan (45^\circ + 1/2 F) = 2 \tan \tfrac{1}{2} F + \tfrac{2}{3} \tan^3 1/2 F + \ldots > 2 \tan 1/2 F$,

and in consequence of it the quantity in brackets $> (e - 1)^2 \cos F$.

Thus, $\frac{\partial y}{\partial F}$ is negative, and y decreases as F increases. From this it follows that $y > 1$, and the relation $r > V_0 t$, is the result.

If we apply this formula to Nova Aurigæ, we obtain for

$\frac{V_0}{V} = 0 \cdot 5$	$\sqrt{V^2 - V_0^2} = 108$ miles,	$V_0 = 60$
0·6	96	72
0·7	86	84
0·8	72	96
0·9	—	108

In the vicinity of perihelion the velocity has been under every condition greater than 120 miles, and we shall therefore obtain values of r that are considerably too small, by supposing $r > t \times 85$ miles. One day before or after perihelion it is therefore certain that $r > 7 \cdot 3$ million miles.

It will therefore hardly be possible to assume that any noticeable influence of the supposed two bodies can have lasted longer than a few hours.

Since the above article was written Nova Aurigæ has by its reappearance attracted considerable attention, and especially by the observation as made by Prof. Barnard. With regard to this reappearance one must necessarily see an evident confirmation of the critical part of my article. Nor has my hypothesis been contradicted in any way, for it is evident in itself that the supposed formations of the nebulous or dusty matter are more copious in certain parts of space, and one may have different ideas of the distribution of density of these formations.

To the observation made by Prof. Barnard (*Astr. Nach.*, 3114) I wish to add the following remarks. I had formed an idea of the whole process which caused the outburst of the Nova, which idea is as perfectly represented in Prof. Barnard's drawing, kindly communicated to me by Prof. Kreutz, as I could expect. During the appearance of the Nova in the winter nothing similar was seen so far as I know. It does not follow from this, therefore, that it did not exist, and it would also have been possible to have expected information from the photographs as has often occurred before. I applied on this account to Dr. Wolf, in Heidelberg, and asked him whether he had photographs of the region of the Nova at that time, and whether, perhaps, any nebulous object was to be seen on them; but, unfortunately, Dr. Wolf did not possess such photographs. It remains doubtful, I am sorry to say, whether so delicate an object would have been visible on the plates. W. J. LOCKYER.

HINTS FOR COLLECTORS OF MOLLUSKS.[1]

AFTER the collector has brought home the spoils of his excursion there is still a good deal to be done before the wet and dirty shells, covered with parasitic growths or inhabited either by the original mollusk or some hermit crab, will be ready to be placed in the cabinet. Some of them, if living, may find a temporary place in an aquarium for the study of their habits, but, for the most part, the collector will wish to prepare his specimens either for anatomical use in the future or as dry specimens for his cabinet. The preparation of mollusks for anatomical purposes has been described in a special chapter of these instructions. For ordinary rough work nothing is better than clean 90 per cent. alcohol diluted with a proper proportion of water. If the specimens are large they should be first put into a jar kept for that special purpose, in which the alcohol is comparatively weak, having, say, 50 per cent. of water added to it. After the immersion of specimens in this jar for several days the fluids will have been extracted by the alcohol, and a specimen can then be removed, washed clean of mucus and dirt, which will almost always be found about the aperture of a spiral shell, and

[1] Reprinted from "Instructions for Collecting Mollusks, and other Useful Hints for the Conchologist," by William H. Dall; issued by the Smithsonian Institution as Part G of *Bulletin* of the U. S. National Museum, No. 39.

placed in its own proper jar of 90 per cent. alcohol diluted in the proportion of 30 per cent. with pure water. Specimens to be prepared for the cabinet require the removal of the soft parts if they are still present, the cleaning off of parasitic or incrusting growths, and, in the case of bivalves, securing the valves in a convenient position for the cabinet. The different classes of shells may be treated under several heads.

Land and Fresh-Water Shells.

Land and fresh-water shells are much more easy to deal with than marine shells. In the case of spiral shells, such as *Limnæa, Planorbis, Paludina*, &c., the shell may first be washed clean of mud or comfervoid growth, which may be conveniently done with the assistance of an old tooth or nail brush. In the case of these forms the easiest way to remove the soft parts is to place the shell for twenty-four hours in weak alcohol, after which those parts can readily be removed; but in any case where the expense of alcohol is an object to be avoided, it will be sufficient to place them in a small tin kettle, or other receptacle suitable for the purpose, and cover them with cold water, which should then be slowly brought to the boiling point. As soon as it has reached the boiling point it may be removed from the fire. The shells should not be put into water already boiling, as it frequently cracks delicate shells, and the sudden change of temperature injures their polish and general appearance.

For removing the soft parts from spiral shells the collector will usually find a crooked pin sufficient. For this purpose one of those long steel pins used by ladies as hat pins is convenient. By heating the pointed end in the flame of a candle or alcohol lamp the temper can be taken out of the steel, so that it can be readily bent into any shape desired. The proper form for reaching the retracted parts in a spiral shell will of course be a spiral. With a small pair of plyers, different forms can be experimented with, and those which are most satisfactory decided upon. After the right form has been obtained, by heating the pin again and plunging it suddenly into cold water, the temper of the steel will be measurably restored and the instrument ready for use. Similar pins in their ordinary condition are convenient for cleaning out sand or parasites from the recesses of sculptured shells, and for other purposes. The attachment of a gastropod to its shell is at the central axis or pillar of the shell, usually from half a turn to a turn and a quarter behind the aperture. By applying the pressure of the extractor carefully in this vicinity the attachment will give way and the extractor may be withdrawn, bringing with it the soft portions of the animal. In large and heavy shells, in which the muscular attachments are strong and deep-seated, and it is desired to obtain a good hold of the animal in order to extract it from the shell ordinary steel fish-hooks may be used. These may be softened by heat, straightened out, and twisted into a spiral of the proper form, and retempered. Then they can be securely fastened to small wooden handles by the shank of the hook. In this way the barb of the hook will assist in retaining the soft parts on the extractor when it is withdrawn from the shell. Several German firms advertise sets of implements for cleaning, cooking, and extracting the animals from shells of mollusks, but it would seem to the writer that any person of ordinary intelligence and some little mechanical ingenuity, such as all naturalists are expected to possess, should be able to provide himself with the necessary apparatus without purchasing expensive paraphernalia of this kind. Shells which have no operculum require merely to be cleaned after the animal has been removed, and in the case of land and fresh-water shells this is usually a very simple matter. Shells which possess an operculum should retain it in the cabinet, as it is often of great value in determining the relations of the species, since the operculum is a characteristic feature in the economy of the animal. It should be detached from the body of the animal after the latter has been extracted from the shell, carefully washed and cleaned, and if flat and horny may be dried between two pieces of blotting paper, under a weight. This will prevent it from becoming contorted in the process of drying. For removing the thick incrustation of lime and peroxide of iron which frequently forms upon fresh-water shells, a few tools resembling engraver's tools or the little chisels in use by dentists for excavating teeth are very convenient. A suitable tool, however, can easily be made by softening and grinding down an old file to a triangular point. A little experience will enable the collector to become expert in scaling off the objectionable matter without injury to the surface of the shell.

Naked slugs should be preserved in alcohol, after being sketched in the living state. Some of the older naturalists had a way of skinning slugs, inflating and drying the empty skins for preservation in their collections, much as entomologists sometimes treat caterpillars; but this ingenious device has nothing to recommend it to a scientific collector, even if he has the dexterity to practise it. The internal shell of such slugs as *Limax* may be represented in the collection if desired, but, in any case, specimens should be carefully preserved in spirits.

The bivalve shells, such as *Unio*, if taken alive, may be left in the sun for a short time, when they will usually open, and, the muscle connecting the two valves being cut, the valves may be cleaned. It is desirable for cabinet purposes to preserve the two valves in their natural position, attached to each other by the ligament which holds them together in life. This ligament dries to a very brittle, horny substance. Consequently the shells must be placed in position when fresh in order to make a success of the operation. After cleaning away the animal matter and thoroughly washing the interior of the shell, it is a good plan to note the locality with a soft lead-pencil upon the shell itself. Then bring the two valves together in their natural position and tie them in that position with a piece of tape or soft twine, which should be allowed to remain until the ligament is thoroughly dry. Specimens prepared in this way are more valuable for exchange and more attractive to the eye than those with which less care has been taken. It is always desirable, however, to have some specimens with separated valves of every bivalve species in the cabinet, in order that the characteristics of the interior may be easily examined.

Fresh-water bivalves are usually covered with a thin and highly polished, often very elegant, greenish or brownish epidermis. Sometimes the shell is so thin that, in drying, the contracting epidermis splits and cracks the shelly portion so that it becomes worthless for the cabinet. This often happens with marine mussels, but it is almost characteristic of the thin fresh-water *Unionidæ*. Various methods have been adopted to prevent this unfortunate result. Some collectors have varnished their shells immediately after they were obtained. Others have used sweet oil or other oils in the hope of keeping the epidermis in a soft condition. These applications are all objectionable for one reason or another, as the first endeavour of the collector who desires to make a really scientific collection should be to keep his specimens as nearly as possible in a perfectly natural condition. The most satisfactory substance for application to the shells in question is probably ordinary vaseline, which should be applied in very small quantities, so that the specimen will have no greasy feeling and will absorb the vaseline sufficiently not to become sticky to the touch. Glycerine, which has been recommended by several collectors, like oil, leaves the surface sticky and offensive to the touch, besides rendering it liable to catch everything in the way of dust with which it may come in contact.

Very small gastropod shells need not have the soft parts removed. If they are put into a vial of alcohol for twenty-four hours, then taken out and allowed to dry, the soft parts will become desiccated without any offensive odour, and they may be placed in the cabinet without further preparation. It may be noted, however, that if the cabinet contains many such shells, care should be taken to guard against the access of mice and vermin, which are apt to attack them in the absence of something more attractive in the way of food. For those shells which possess an operculum, after the operculum has been dried and the shell cleaned and ready for the cabinet, it is customary to insert a little wad of raw cotton, rolled so as to fit the aperture snugly, the outer surface of it being touched with a drop of mucilage. The operculum can then be laid upon this in its natural position and the mucilage and cotton will retain it so without making it difficult to remove for an examination of the shell if desired at any time. For the preservation of eggs of mollusks when they have a horny or calcareous shell, small glass tubes securely corked are the best receptacles. Most of these eggs are so small that they may be preserved in a dry state or in alcohol without trouble, but the eggs of some of the tropical land snails are so large that it will be necessary to drill a small hole and extract the fluid contents as if they were bird's eggs in order to preserve them. Such eggs are the best preserved in alcohol.

Marine Shells.

The preparation of marine shells for the cabinet does not essentially differ from that required for land or fresh-water shells, except that in the marine shells the muscular system is

often much more strongly developed and the creatures themselves much larger than the fresh-water forms, and the manipulation is therefore somewhat more difficult. The marine forms are also more apt to be incrusted with foreign bodies, bored by predatory sponges, like *Cliona*, or even by other mollusks, or perforated by certain annelids which have the power to dissolve the lime of which the shell is composed, and in this way secure a retreat for themselves.

Shells which do not contain the living animal are frequently occupied by hermit crabs or by tubicolous annelids. The latter fill up the larger part of the spire with consolidated sand or mud, in the centre of which they have their burrow. The hermit crabs do not add anything to the shells which they occupy, but, on the contrary, by their constant motion are apt to wear away the axis or pillar of the shell, so that often a specimen of this sort may be very fairly preserved and yet on the pillar show characters entirely different from those which one would discover in a specimen which had never been occupied by a crab. A shell which the crab has selected for its home is often taken possession of, as far as the outside is concerned, by a hydractinia, a sort of polype, which produces a horny or chitinous covering which is very difficult to remove from the shell to which it is attached. As the hydractinia grows it finally covers the whole shell, to some extent assumes its form, and then, if the creature has not attained its full growth, this is apt to take place around the edges of the aperture, which are continued by a sort of leathery prolongation which assumes in a rough way the form of a shell. The crab, when he grows too large for the shell in which he has ensconced himself, is usually obliged to abandon it and find a larger one, which is always a difficult and more or less dangerous operation ; but if his shell is overgrown by the polype referred to, it often happens that the polype and the crab grow at about an equal rate, so that the latter finds himself protected and does not have to make a change. It is supposed that the polype profits to some extent by the microscopic animals attracted by the food or excrement of the crab, so that this joint housekeeping is mutually beneficial, and, for such cases, since the word *parasite* would not be strictly accurate, the word *commensal* has been adopted. These modified shells often assume very singular shapes. The polype is able in the course of time to entirely dissolve the original calcareous shell upon which its growth began, so that if the spire be cut through it would be found throughout of a horny or chitinous nature. Some of the older naturalists were deceived by forms of this sort and applied names to them, supposing that they were really molluscan shells of a very peculiar sort.

In removing the animal matter from the shell of large gastropods it will often require a good deal of time and care to get out all the animal matter from the spire, but it is well worth while to take the trouble, as the presence of such matter forms a constant attraction for museum pests of all descriptions. A medium-sized syringe is convenient for washing out the spire of such shells. The ordinary marine gastropods may be treated in a general way like the fresh-water gastropods. There are, however, abnormal forms, especially among tropical species, which require particular attention. Some species become affixed to corals and overgrown by them, retaining only a small aperture through which the sea water can reach the prisoner. Such specimens are best exhibited by retaining a part of the coral and cutting the rest away, showing at once the mode of occurrence and the form of the covered shell. Borers are always more difficult to handle and prepare for the cabinet than other mollusks. They are usually more or less modified for their peculiar mode of life, and frequently rely upon their burrow as a protection, so that the shell is reduced, relatively to the animal, to a very small size. Most of these forms are best kept in alcohol. The hard parts may properly be represented in the cabinet by other specimens. Some of the bivalves, such as the American "soft clam," possess very long siphons, covered with a horny epidermis, and it becomes a question as to whether an attempt should be made to preserve this epidermis in the cabinet or not. The writer has seen very nicely prepared specimens in which the fleshy portions had all been taken out and replaced by cotton, so that the epidermis of the siphon retained its original position and form ; but such specimens are always very delicate, easily broken, and liable to attack by insects, so that it would seem hardly worth while to go to the trouble, when specimens may be preserved complete in alcohol showing all the features referred to. Boring shell-fish, like *Pholas*, frequently have accessory pieces, which are liable to be lost when the soft parts are removed unless care is taken to avoid it. Other bivalves have the internal ligament reinforced by a shelly plate, which is called the ossiculum. This is very easily detached and lost, and, being an object of great interest, special pains should be taken to preserve it, even if it should become detached.

JAPANESE CAMPHOR.

THE United States Consul at Osaka gives in a recent report the following particulars, reprinted from the November number of the *Board of Trade Journal*, respecting the Japanese camphor trade :—

The camphor tree, from which the resinous gum is distilled, is a species of the laurel, and is found in the provinces of Tosa, Hiuga, and Satsuma, in the south of Japan. Large groves of the trees are owned by the Japanese Government, the wood being very desirable for shipbuilding. The districts in which the camphor tree is found are mountainous and situated far from the sea. No reliable information can be obtained as to the cost of producing the gum before being transported in junks to Hiogo. The peasants who engage in distilling the roots and branches of the trees are said to be poor, and employ the rudest machinery.

The market value of crude camphor gum and of oil of camphor per picul ($133\frac{1}{3}$ lbs.) during the past year was as follows :— Drained, 38·25 dols. : wet, 37·00 dols. ; old dry, 43·50 dols. ; average, 36·50 dols. ; camphor oil, 5·25 dols.

The highest and lowest prices during the same period were as follows :—Highest, 40·00 dols. ; lowest, 33·00 dols.

Camphor gum is exported in tubs measuring about $6\frac{1}{2}$ cubic feet ; oil in kerosene tins and cases. The grades are from old dry down to new wet, and the various grades depend upon the quantity of adulteration. In oil there are two grades—white and brown.

Adulteration is practised for the most part by adding water and oil just as far as the buyer will tolerate. In some cases 20 lbs. of water will run out of a tub in twelve hours. The unadulterated article, known as the good old dry, can sometimes be bought. The only system of tests in determining value of the different qualities is by burning and by absolute spirit. The percentage of pure camphor which the crude yields when refined varies according to the quality of the crude. The average percentage of gum produced from the wood as compared with the original weight of the wood cannot be accurately ascertained here, the only foreigner known to have visited the camphor districts having declined to furnish any information on the subject.

The total exports of camphor from Hiogo during 1891 in catties of $1\frac{1}{3}$ lbs. each amounted to 3,850,400 catties consigned to the following destinations : Europe (countries not specified), 1,777,300 catties ; London, 335,600 catties ; Germany, 209,200 catties ; United States, 1,277,000 catties ; China, 51,900 catties ; France, 199,400 catties.

As regards the manufacture of camphor the following particulars are extracted from a report by the United States Consul at Nagasaki.

Camphor is found alike on high elevations and in the valleys and lowlands. It is a hardy, vigorous, long-lived tree, and flourishes in all situations.

Many of these trees attain an enormous size. There are a number in the vicinity of Nagasaki which measure 10 and 12 ft. in diameter. The ancient temple of Osuwa, at Nagasaki, is situated in a magnificent grove of many hundred grand old camphor trees, which are of great age and size, and are still beautiful and vigorous. It is stated that there are trees at other places in Kiu Shiu measuring as much as 20 ft. in diameter. The body or trunk of the tree usually runs up 20 and 30 ft. without limbs, then branching out in all directions, forming a well-proportioned, beautiful tree, ever green and very ornamental.

The leaf is small, elliptical in shape, slightly serrated, and of a vivid dark-green colour all the year round, except for a week or two in the early spring, when the young leaves are of a delicate, tender green. The seeds or berries grow in clusters and resemble black currants in size and appearance. The wood is used for many purposes, its fine grain rendering it especially valuable for cabinet-work, while it is used also for shipbuilding. The roots make excellent knees for ships.

In the manufacture of camphor the tree is necessarily destroyed, but, by a stringent law of the land, another is planted

in its stead. The simple method of manufacture employed by the natives is as follows:—

The tree is felled to the earth and cut into small pieces, or, more properly speaking, into chips.

A large metal pot is partially filled with water and placed over a slow fire. A wooden tub is fitted to the top of the pot, and the chips of camphor wood are placed in this. The bottom of the tub is perforated so as to permit the steam to pass up among the chips.

A steam-tight cover is fitted on the tub. From this tub a bamboo pipe leads to another tub, through which the enclosed steam, the generated camphor and oil flow. This second tub is connected in like manner with a third. The third tub is divided into two compartments, one above the other, the dividing floor being perforated with small holes, to allow the water and oil to pass to the lower compartment. The upper compartment is supplied with a layer of straw, which catches and holds the camphor in crystal in deposit as it passes to the cooling process. The camphor is then separated from the straw, packed in wooden tubs of 133⅓ lbs. each, and is ready for market.

After each boiling the water runs off through a faucet, leaving the oil, which is used by the natives for illuminating and other purposes.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. W. Ridgeway, late Professor at Queen's College, Cork, has been elected to the Disney Professorship of Archæology for the customary period of five years. Prof. Ridgeway's recent work on the origins of weights and measures have made him well known as a scientific archæologist.

Mr. R. T. Glazebrook, F.R.S., Assistant Director of the Cavendish Laboratory, has been appointed a member of the Financial Board; Mr. Lewis, Professor of Mineralogy, and Dr. Gaskell, F.R.S., have been elected members of the General Board of Studies; and Mr. E. W. MacBride, Scholar of St. John's College, has been appointed Demonstrator in Animal Morphology, in the place of Mr. J. J. Lister, of the same College.

The Museums and Lecture Rooms Syndicate propose to introduce the electric light into the dissecting-room of the Anatomy school, the lecture room, and histology class-room of the Department of Physiology, and the Philosophical Library, at an expense not exceeding £100.

By the death, on November 30, of Dr. F. J. A. Hort, Lady Margaret Professor of Divinity, the University has lost not only a great theologian, but a distinguished student of science. Dr. Hort was second to Prof. Liveing in the Natural Sciences Tripos of 1851, the first ever held. He received the mark of distinction in Physiology and in Botany. In 1856, and again in 1871, he was an examiner for Honours in this Tripos. Throughout his life his interest in the scientific progress of the University was deep and hearty.

A Syndicate has been appointed to consider the whole question of the times of holding Tripos examinations, and the changes that would follow if these were altered. The disadvantages of the present system, by which much of the benefit of the Easter term and of the Long Vacation are lost to students and teachers alike, have of late been forcibly brought before the Senate. It is to be hoped that, by bringing about a rational "Easter" or otherwise, the Syndicate's efforts may lead to a reformation.

SCIENTIFIC SERIALS.

American Meteorological Journal, November, 1892.—Wind measurement by H. W. Dines. The two instruments generally in use, viz. the Robinson cup anemometer and the pressure plate, are both more or less unsatisfactory in obtaining the extreme pressure. The wind never blows uniformly, whereas the instruments are calibrated on the supposition that it does so. And the method of exposure is often unsatisfactory; any obstacle to the free circulation of the wind either at the side or even behind or below the anemometer, vitiates the results. The usual factor k for conversion of velocity to pressure in the equation $P = kv^2$ is too high. The value ·005 was given originally in a book on engineering, with a footnote stating that the experiments on which it rested were doubtful, but it has since been copied without the note. Recent experiments show that ·003 is probably more correct, but with such a varying element as the wind, any factor is of little use in deducing extreme pressures from velocity anemometers. Instruments of different sizes give different results, and those calibrated by indoor trials give more wind than those tested out of doors. In some respects it is more desirable to register the pressure than the velocity, but a pressure plate which is to register 30lb. per square foot is hardly suitable to record so small a force as one ounce, so that on many days no sign of motion is given. The author concludes from many careful experiments that the tube form of anemometer is most likely to give satisfactory results, as, apart from electricity, it is the only kind in which the motion or pressure can be transmitted to a distance without loss by friction. In this instrument the registering apparatus is placed away from the part exposed to the wind.—The storms of India, by S. M. Ballou. In this article, which is a continuation of previous papers, the author treats of the storms which accompany the winter and summer rains.—The first aerial voyage across the English Channel, by R. de C. Ward. This voyage was successfully carried out by Dr. Jeffries and M. Blanchard on January 7, 1785. The balloon left Dover at 1h. p.m., and descended a few minutes before 4h. p.m., not far from Ardres.—On the production of rain, by Prof. C. Abbe. The author reviews the natural process of the formation of rain, viz. saturation by aqueous vapour, condensation into visible particles, and the agglomeration of these into drops large enough to be precipitated. The problem of artificial formation of rain will be partially solved if some method is invented to bring about a sudden formation of large drops out of the moist air that exists between the small particles of every cloud.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, November 28.—M. d'Abbadie in the chair.—Note accompanying the presentation of a work on the new methods of the "Mécanique Céleste," by M. Poincaré.—On the existence of distinct nervous centres for the perception of the fundamental colours of the spectrum, by M. A. Chauveau. If one goes to sleep on a seat placed obliquely in front of a window which allows the light from white clouds to fall equally on both eyes, the coloured objects in the room appear illuminated by a bright green light during a very short interval when the eyelids are opened at the moment of awakening. The phenomenon is not observed except at the moment of awakening from a profound sleep. From this it is concluded that there are distinct perceptive centres for the green, and probably also for the violet and the red. Of these, the green centres are those which first regain their activity on awakening.—Note on the observatory of Mont Blanc, by M. J. Janssen.—On the laws of expansion of liquids, their comparison with the laws relating to gases, and the form of the isothermals of liquids and gases, by E. H. Amagat. The substances examined were water, ether, alcohol, carbon bisulphide, hydrogen, nitrogen, air, oxygen, ethylene, and carbonic acid, the pressures ranging from 50 to 3000 atmospheres, and the temperatures from 0° to 200°. For both liquids and gases, the isothermals present a slight curvature turned towards the axis of abscissæ. The angular coefficient increases with the temperature. This effect is specially pronounced in the liquids, where it corresponds to a widening-out of the network, well exemplified in carbonic acid, in the part corresponding to the lower temperatures. This widening-out gradually disappears as the temperature rises; in the lighter gases, the variation with the temperature is very small.—Observations of Holmes's comet ("*f*" 1892), made at the Paris Observatory (west equatorial), by M. O. Callandreau.—On a remarkable solar protuberance observed at Rome on November 16, 1892, by M. P. Tacchini.—On universal invariants, by M. Rabut.—On straight-line congruences, by M. E. Cosserat.—On the passage of a wave through a focus, by M. P. Joubin. An apparatus for showing the complementary character of transmitted and reflected Newton's rings is mounted vertically, and illuminated by a small bright point placed at a distance of 1·20m. along the axis of symmetry. On moving a microscope along the axis of reflection the rings first appear with a black centre, which changes into white at the first focus of reflection, and again into black at the second.—On the depression of the zero, observed in boiled thermometers, by M. L. C. Baudin. The secular

depression of the zero, brought into prominence by heating to 100°, may be greatly reduced by keeping the thermometers for several days immersed in a liquid boiling at 400° or 500°.—On the fusion of carbonate of lime, by M. A. Joannis.—Action of antimony on hydrochloric acid, by MM. A. Ditte and R. Metzner.—On the zincates of the alkaline earths, by M. G. Bertrand.—On anhydrous and crystallized fluorides of iron, by M. C. Poulenc.—Preparation of metallic chromium by electrolysis, by M. Em. Placet. An aqueous solution of chrome alum, to which is added an alkaline sulphate and a small quantity of sulphuric or other acid, is electrolyzed. Pure chromium is deposited at the negative pole. It is very hard, and of a fine bluish-white colour. It resists atmospheric influences, and is not attacked by concentrated sulphuric acid, by nitric acid, or by concentrated potash solution. Articles made of brass, copper, or iron may be coated with chromium, thus giving them a metallic lustre resembling oxidized silver. Large quantities of the metal can be prepared without difficulty.—On the preparation of hydrobromic acid, by M. E. Léger.—Reply to M. Friedel's observations on the rotatory power of the diamine salts, by M. Alb. Colson.—Point of fusion of solvents as the inferior limit of solubilities, by M. A. Etard.—Action of the chlorides of dibasic acids on cyanacetic sodium ether; succinodicyanacetic ether, by M. Th. Muller.—On the functions of hydurilic acid; preparation of potassium hydurilates, by M. C. Matignon.—Researches on the colours of some insects, by M. A. B. Griffiths.—Microbicidal action of carbonic acid in milk, by M. Cl. Nourry and C. Michel.—On a nervous ganglion of the feet of *Phalangium opilio*, by M. Gaubert.—Myxosporidia of the bile-duct of the Fishes; new species, by M. P. Thèlohan.—On the modifications of absorption and transpiration which occur in plants under the influence of frost, by M. A. Prunet. The rapid dessication of the young shoots of frozen plants is due to the substitution of an intense evaporation for the normal function of transpiration, and to an almost complete suspension of absorptive functions.—*Æcidiconium*, a new genus of Uredinei, by M. Paul Vuillemin.—On the clasification and the parallelisms of the miocene system, by M. Ch. Depéret.—On the existence of micro-granulite and orthophyre in the primary formations of the French Alps, by M. P. Termier.—On the mineralogical modifications of the calcareous strata in the inferior Jurassic of Ariège due to lherzolite, and their bearing on the history of this eruptive rock, by M. A. Lacroix.—On the geographical distribution, the origin, and the age of the ophites and lherzolites of Ariège, by M. de Lacvivier.—Geological observations on the *Creux de Souci* (Puy-de-Dôme), by M. Paul Gautier.

BERLIN.

Physiological Society, October 28.—Prof. du Bois Reymond, President, in the chair.—Prof. Gad spoke on the respiratory centre on the basis of experiments made in his laboratory by Herr Marenescu. According to these, the centre for the co-ordination of the respiratory muscles lies in the *formatio reticularis grisea* and *alba* below the hypoglossal centre, on each side of the hypoglossal tract, whereas in the apex of the *calamus scriptorius* there is an inhibitory centre (nœud vital) whose stimulation may cause death. It further appeared from these experiments that the respiratory centre is not confined to a limited area, but is diffuse and quite distinct from Flouren's "nœud vital."

November 11.—Prof. du Bois Reymond, President, in the chair.—Dr. Ad. Loewy had investigated the influence on respiration of the upper tracts leading from the cerebrum to the respiratory centre, an influence which is specially marked after section of the vagi. He found that these tracts do not simply hand on to the centre impulses received from the periphery up the trigeminal nerve, but that they automatically maintain the rhythm of the centre after the vagi have ceased to function. Dr. René du Bois Reymond spoke on the sensation of warmth which ensues on immersing the hand in a vessel of carbon dioxide. Sulphurous acid, bromine vapour, nitrogen peroxide, ammonia and hydrochloric acid gas produce the same effect. The intensity of the sensation varies with the different gases. Thus carbon dioxide produces the same sensation as air warmed to 20°, while that of nitrogen peroxide is as of air at 30° and that of ammonia and hydrochloric acid gas as of air above 40°. The phenomena do not as yet admit of a physical explanation, but must be regarded rather as resulting from a chemical stimulation of the sensory nerves for heat perception. The President exhibited a torpedo recently born in Berlin, in which he had detected an active electric organ immediately after birth, by means of a nerve-muscle preparation and a galvanometer. This observation was first made in 1831 by Davy, but had not since then been repeated.

BOOKS, PAMPHLETS, and SERIAL RECEIVED.

BOOKS.—The Scenery of the Heavens: G. E. Gore. 2nd edition (Sutton).—Johnston's Catechism of Agricultural Chemistry, from the Edition by Sir C. A. Cameron, revised and enlarged by C. M Aikman (Blackwood).—Coal Pits and Pitmen: R. N. Boyd (Whittaker).—Practical Electric-Light Fitting: T. C. Allsop (Whittaker).—Sound and Music: Rev. J. A. Zahm (Chicago, McClurg).—Results of Meteorological Observations made in New South Wales, 1880, 1881, 1882, 1883, and 1884 (Sydney, Potter)—Mineral Resources of the United States, 1889–90: D. T. Day (Washington).—Proceedings of the American Association held at Washington (D.C.)—Meteorological Observations and Results at the U.S. Naval Observatory, 1888 (Washington D.C.).—Magnetic Observations at the U.S. Naval Observatory, 1891 (D.C.).—The Building of the British Isles: A. J. Jukes-Browne. 2nd edition (Bell).—Poems in Petroleum: J. C. Grant (E. W. Allen).—Electric Lighting and Power Distribution. Part 1: W. P. Maycock (Whittaker).—Old and New Astronomy: R. A. Proctor, completed by A. C. Ranyard (Longmans).—Painters' Colours, Oils, and Varnishes: G. H. Hurst (Griffin).—Elementary Mechanics of Solids and Fluids: A. L. Selby (Oxford, Clarendon Press).—The Chemistry of Life and Health: C. W. Kimmins (Methuen).—The Mechanics of Architecture; E. W. Tarn (Lockwood).—Electrical Papers. 2 vols.: O. Heaviside (Macmillan).

PAMPHLETS.—Notes de Géographie Litterale: J. Girard (Paris).—Physical Geography and Climate of New South Wales: H. C. Russell. 2nd edition (Sydney, Potter).—La Grandissima Macchia Solare del Febbraio, 1892: A. Ricco (Rome).—Fumo di Vulcano: A Ricco (Rome).—Sopra il Periodo Eruttivo dello Stromboli: A. Ricco. G. Mercalli (Rome).—Ueber Heterogene Induktion versucheines Beitrags zur Kenntnis der Reizerscheinungen der Pflanzen: Dr. F. Noll (Leipzig, Engelmann)—Observations on Dew and Frost: Hon. R. Russell (Stanford).—The Cry of the Children: A Free Lance (Williams and Norgate).

SERIAL.—Insect Life, vol. 5, No. 2 (Washington).

CONTENTS.

THURSDAY, DECEMBER 15, 1892.

CRITICISM OF THE ROYAL SOCIETY.

A "Criticism of the Royal Society" which appeared in the *Times* of December 1st, is so obviously the work of a writer unacquainted with the inner life of the Society, that it might well have been left to "waste its sweetness on the desert air," had it not been taken seriously in an editorial article of the same issue of the leading journal. In fact, the relations of the "Criticism" to the editorial leader suggest that the discharge of these bombs into the scientific camp was carefully arranged; the writer of the criticism having managed to persuade the editor of the *Times* that the Society is in a bad way. That really is a serious matter, and justifies a brief but careful critique of the "Criticism."

The "Criticism" says:—"The Royal Society is officially and statutorily described as the 'Royal Society for improving natural knowledge,' that is to say for promoting and rewarding original investigation."

The first half of this statement is quite correct, but the second is as completely erroneous. From its earliest days the Royal Society has conferred its Fellowship on persons who had nothing to do, directly, with original investigation, but were promoters of the "improvement of natural knowledge" in other ways. And so very loosely were the conditions of admission construed, half a century ago, that the Society was in danger of sinking into a mere club. From this fate it was rescued by the reform effected by the vigorous efforts of Sir W. Grove and the late Mr. Leonard Horner, which restricted the number of new fellows to be annually *se*lected (not *e*lected) by the Council to fifteen. These fifteen names are presented to a General Meeting which may, if it pleases, reject any or all of them and substitute more or fewer other names. The control of the Society at large is absolute. Nevertheless, in the five and forty years during which this arrangement has existed, we can call to mind only one occasion in which a decision of the Council was seriously challenged in the General Meeting and a name omitted by the Council added to the list. On the face of it, this does not look as if the Council had abused its power of selection.

The "Criticism" proceeds:—"It will hardly be contended by any one at all conversant with the matter that fifteen elections per annum are inadequate for the due recognition of really original work. On the contrary, it is only by a loose and wide interpretation of the governing clause in its constitution that the Royal Society can fill up, year by year, the full number of its permitted elections."

Yet every one "at all conversant with the matter" is perfectly well aware that sundry persons of just weight and authority in the Society have, for some time, been of opinion that the fifteen elections are inadequate even for the purpose of recognizing original work; and that, for a number of years, this view has been pressed now and again on the Council. It is said that if fifteen were considered barely enough forty-five years ago, the prodigious increase of scientific workers, especially in Great Britain and the Colonies, during that time, must have rendered that number insufficient for the present day; and that, seeing the necessity of allotting a fair share of the elections to each of the representatives of the many different branches of Science in a list o candidates whose number averages about sixty, the election of men who ought to come in is, every year, necessarily postponed. We offer no opinion on this difficult question; but that the facts are as we state them is notorious to every one who has served upon the Council. However, it is easy to submit the selective work of the Council to an effectual test. In the last twenty years 300 Fellows have been elected. Let any competent judges go over the names of these gentlemen, with the view of picking out ten whose right to be there admits even of being fairly questioned. We are confident that he will not succeed in finding that number, nor the half of it. No body of men ever has been, or ever will be, unaffected, to some degree, by personal influences, or prejudices, or errors of judgment; even ecclesiastical preferment is said not always to follow in the track of the purely spiritual gifts and graces. But a Council which can defy all hostile criticism of 295 out of 300 of its selections, and fairly defend the rest, may cheerfully meet its enemies in the gate.

The "Criticism" exhibits a no less curious ignorance of the actual facts in dealing with the relations of the officers to the Council. The critic knows nothing of the curious revolt that took place a score of years ago, aided and abetted by the majority of the officers of that time, for the purpose of rendering themselves powerless in face of the rest of the Council. He does not know that, subsequently, officers of the Society have over and over again urged that prolongation of the term of service of the rest of the members of the Council which can alone enable them to take the share they ought to take in the government of the Society. Few persons are aware of the great amount of business—some of it of a very troublesome and responsible character—which comes before the Council of the Royal Society. In his first year of office, a new councillor is a learner; at the end of the second year, just when he is becoming useful, he goes off, by a rule which the general body of the Fellows object to alter. Formerly the President's term of office was unlimited; now it has practically reduced itself to five years. Unless the other officers—and particularly the principal secretaries—retained their offices for a longer time, the affairs of the Society would soon either be reduced to chaos, or be carried on, somehow or other, by the one permanent official—the Assistant Secretary. The Society could not have a better Assistant Secretary than it possesses, but he has no seat in the Council; and even if it were desirable to reduce the secretaries to nullities, the situation would become impossible. Under these circumstances, it is clear that the officers must know more about the business of the Society than ordinary members of the Council; that, therefore, willy-nilly, they must exercise a preponderating influence; and, finally, that it is desirable that they should do so.

Again, the insinuation that this influence is exerted unfairly, in favour of a particular academical institution could not have been made by any one acquainted with the actual government of the Society. Of the officers two are members of Scottish Universities, one of these

and two of the others, of the University of Cambridge, one has been honoured by both Oxford and Cambridge degrees. Where is the "excessive representation of one great academical institution" among these gentlemen? Undoubtedly one of the English Universities has a large share; but, if the author of the "Criticism" imagines that the influence of that University, or of any member of it acting on behalf of his University, had anything whatever to do with the election of these officers to the posts they hold, it is simply because he is utterly unacquainted with the circumstances under which these appointments were made; and more especially with the difficulty of finding competent men who are able and willing to devote an immense amount of time and trouble to the affairs of the Society.

So with respect to the "reappearance" of similar names on the Council "every five or six years." If the critic had ever taken part in the business of selecting a new Council; or even if it had occurred to his somewhat captious mind (1) that all branches of science must be represented; (2) that men who can and will give a great deal of time to the service of the Society are alone useful; (3) that it is not everybody's business to be a useful councillor; (4) that people who live far out of London, as a rule, find it difficult to attend the frequent meetings of the Council and its committees, he would not have found it necessary to suggest corrupt motives for this fatal reappearance of the same councillors; and that in spite of the rule that a man must be off the Council for a year before he can be re-elected.

It is further made a reproach to the Society that among the yearly elected fifteen "the professor abounds greatly, while independent investigators of the type of Joule, Brewer, Spottiswoode, De la Rue, Darwin, Gassiot, Grove, and others who have been the glory of English science, are comparatively rare." To which singular statement (most singular perhaps in the collocation of names) it would seem necessary to reply only by putting two questions. Will the critic point to any man ranking even with the least known of those whom he mentions, now living, who is not in the Royal Society, or who has not been placed on the Council, except of his own choice, or from the accidents of residence and occupation? And, secondly, has it occurred to him that in the last quarter of a century, a multitude of new professoriates in science have been created, and have been filled by the best workers the appointers could find? And if these gentlemen have not left off working the moment they were made professors, does it not seem probable that the Council of the Royal Society may have had even better grounds for selecting them for the fellowship than their appointers had for making them professors?

Finally, the "Criticism" affirms that "eminent professors may be named who are also eminent improvers of natural knowledge, yet are not fellows of the Royal Society."

We venture respectfully, but firmly, to question the accuracy of this statement; unless these "eminent improvers of natural knowledge" have voluntarily abstained from seeking the fellowship. It is not for the Council to ask any one, however "eminent," to join the Society. And if there are persons who have been glad to accept honours from the Royal Society's hands, but who have chosen to abstain from taking the steps which would, as a matter of course, have placed them in its ranks and have enabled them to take their fair share in the burden of its work; no one but themselves is responsible for their singular position—the Royal Society *farà da se*, and does not require their aid.

THE ELEMENTS OF PHYSIOLOGY.

Elements of Human Physiology. By E. H. Starling, M.D. Lond. (London: Churchill, 1892.)

IF this book is intended as an introduction to the physiology a medical student ought to acquire it will fill its purpose admirably, but it would be too much to say that it could in any way take the place of the larger text-books. Such a book as this, rightly bearing the word "elements" in its title, if used, as it should be, as a "guide," will give the student an acquaintance with the subject which will be an excellent introduction to more detailed works. Dr. Starling has written in some 400 small 8vo pages a concentrated account of the physiological processes of the body. The knowledge given is fully up to date. It must have been a difficult task to do this in so small a space without merely recording a succession of disconnected facts and rival theories. Dr. Starling is to be congratulated on having accomplished this task well. The judicious selection he has made of the really important points, and his terse and clear mode of expression has enabled him to produce a book which besides being instructive is interesting, which with a condensed manual is seldom the case. The danger of the book lies in its excellence. If a student, a medical student aiming at a mere qualification trusts, with the aid of some histology, to this book alone, he may doubtless accomplish his immediate object. But who would then be satisfied that he possessed a knowledge of physiology such as a medical man should be equipped with? If the student could not merely learn, but also assimilate all that is brought before him here, his mind would not only be supplied with much information, but also receive a useful training. The experience of teachers, however, is that the average student does not understand the intricacies of many of the processes and mechanisms of the animal body by having them tersely expounded to him in a few sentences. He may learn those sentences, but his ignorance is at once exposed if he is brought face to face with the same question along another path. The more a medical man knows of what physiology can teach him of those portions of the science which come into the most intimate relation with medical practice, all the better. The danger is that when this book falls into the hand of the student he will be satisfied, and refrain from consulting fuller works or even from practical laboratory work, on the importance of which the author in the preface so rightly insists.

The introduction gives not only an account of the general properties of living matter, but also a rapid survey of the build and functions of the animal body, touching even on development. This is followed by an account of the chemical constituents, and as this must be largely referred to by the student during the reading of the book, it is a necessity, but would, I think, have been better placed at the end.

In the chapter on blood and lymph a fuller account of leucocytes with their varieties and functions, and especially of the proteid and other substances associated with them, would certainly have been desirable. It is of course easy, in reviewing so small a book, to find instances of curtailment and of omission, but the life history of the leucocytes is of supreme importance medically, that even the account of the derivatives of hæmoglobin might, for their sake, have been shortened.

The phenomena of muscular contraction are well described, and the account of muscle and nerve currents is especially clear and to the point.

In the chapter on the vascular mechanism two tracings of pressure in an artificial schema are taken from Prof. Foster's text-book. The tracings are accurately reproduced. In the description of these we are told that, after a high peripheral resistance is introduced into the circuit, "the pressure on the arterial side at first rises with every beat till it has attained a certain height, where it remains stationary, merely oscillating with every stroke of the pump. The venous manometer, on the other hand, shows no rise of pressure, and its oscillations becomes less and less, till they disappear and the flow becomes continuous." A glance at the tracing shows, however, that there is a rise of pressure on the venous side, and moreover a maintained rise. This is a very important point about the tracing. A student grasps readily the action of the arterial blood pressure in forcing the blood from the aorta to the capillaries, but he is at a loss to understand why it comes back again from the capillaries towards the heart. It cannot be too much insisted on that we have a pressure, a small and gradually falling pressure, in the veins, and that this is the important determining cause of the venous flow. The author, in this the proper place to bring this prominently forward, leaves it out entirely, though it is incidentally referred to later on, and leads the student to suppose that the presence of the valves in the veins and the aspiration of the thoracic movements, important though they may be, are the chief factors.

The subject of endocardial pressure and of the pulse is treated, clearly and concisely, in the light of Hürthle's important work. This is particularly welcome, as, if I am not mistaken, this is the first occasion that these researches have been brought before English readers.

In the discussion of the causation of the heart's beat it does not seem clear why "the beat always starts in the sinus" when we are told that the sinus contracts feebly and slowly. The fact that the sinus has a more rapid rhythm than the other chambers of the heart, and so initiates the whole cycle, is not distinctly brought out. The author follows Schmiedeberg's opinion in stating that muscarin acts by stimulating the nerve-endings of the vagus. This is by no means certain, and we should have welcomed some mention of Gaskell's opinion that its action is a direct one on the muscular tissue, and some of the reasons for taking that view. In the description of the vasomotor mechanisms I have found no adequate statement of the important part vaso-dilator nerves play in regulating the circulation in skeletal muscle.

In the account of the nervous mechanism of respiration, which is well up to date, in including some of the results of the work of Head, we should have expected also some statements of Marckwald's observations on the influence of section of the medulla above the respiratory centre. No reference seems to be made of the influence of impulses reaching the respiratory from higher centres of the brain. It is also unfortunate that when the student turns, as directed, to Fig. 61 he finds that the tracing selected of the effect on the respiration of section of the vagi does not show the increase in amplitude as it does the decrease in rate, although he is told that both the changes are brought about. On page 266 there is an obvious misprint; the word "expiratory" should be "respiratory." On page 291 there is another misprint, "B_2" in the equation should be, of course, "Br." A few lines further on there is, however, a serious error. We read, "From the amount of nitrogen given off the amount of urea present in the urine, may be calculated. 35·5 c.c. of nitrogen correspond to one gram of urea." The theoretical amount calculated for one gramme of urea is 372·7 c.c. at standard temperature and pressure, while 35·5, or more exactly 35·4 c.c., is the amount which Hüfner found was actually liberated not by one gramme, but by one decigramme of urea.

The chapters on the special senses and on the central nervous system are some of the best in the book. The methods of tracing fibres in the cord and brain are fully gone into, so also is localization of function, and indeed the account of the brain throughout is very clear and good.

At the end of the book is a short appendix, in which is given a description of apparatus purely physical in nature. Every teacher will agree with the author that it is not only desirable, but necessary, to put this in a manual of physiology. The ignorance of the construction and use of the simplest physical apparatus, which the average medical student carries with him into the physiological laboratory, is usually almost as perfect as it can be. Much of the time of a demonstrator of physiology has at first to be given to the teaching of some of the simplest physical methods. L. E. S.

APPLIED MECHANICS.

Elementary Manual on Applied Mechanics. By Prof. Jamieson. (London: C. Griffin and Co., Limited, 1892.)

THIS is the latest addition to the series of books introduced by Prof. Jamieson during the last few years. Like his useful work on the Steam Engine, it is the outcome of the course of lectures which he delivers to his own students. It is replete with the many mechanical contrivances to be found in the workshop, one chapter being devoted to the consideration of the screw-cutting lathe alone.

The illustrations, with which the book abounds, and the necessary descriptions of the various machines considered, are all that one may wish for.

An excellent feature of the book will be found in the manner in which, after having enunciated a principle, the author has applied it to some well-chosen examples. In this direction he has proceeded to an extent which will be highly appreciated by the student. Further, he has availed himself of any opportunity to obtain results experimentally, and these form a very instructive series of examples for the young engineer.

A careful perusal will show that the author considers it desirable that all matters pertaining to units, definitions, symbols, &c., should be carefully attended to. But in his treatment of these he has not been entirely successful.

Take, for instance, his definition of the moment of a force on p. 15:—"The moment of a force is equal to the force multiplied by the perpendicular distance from a point on its line of action." This is rather ambiguous, and we should prefer to see the words, *with respect to a point*, included in the definition.

In a footnote, p. 214, objection is taken to f being used for acceleration, since it "naturally represents a force." Then why use e for strain in the formula $e = \frac{l}{L}$, where e just as naturally represents an elongation, and strain is not an elongation, as the author clearly shows in another footnote on p. 232?

Again, in a footnote on p. 2 we have: "$M = \frac{W}{g}$, where M stands for the mass, W for the weight in pounds, and g for the acceleration of gravity."

Now on p. 215 the reader is asked to accept as correct the formula for centrifugal force, $P = \frac{Wv^2}{gr}$ lbs., but (continues the author) since $M = \frac{W}{g}$, then $P = \frac{Mv^2}{r}$ poundals. Why should this substitution produce the change from pounds to poundals? We fail to see what is gained by having an ellipse for the figure representing motion in a circle.

There is a want of consistency when an acceleration is spoken of as "a feet per sec. in one second" in one place, and as "a feet per sec." on p. 219. On the same page, too, $\frac{Wv^2}{2a}$ should evidently be read as $\frac{Wv^2}{2g}$.

The examples worked out in the chapter on bending moments will show the student how to apply the principle of moments to the case of a beam loaded in any given manner. This is preferable to merely using a set of formula, a system attended with most disastrous results.

At the end of each chapter will be found a good selection of examples on the matter considered therein. We are informed that another volume dealing with the more advanced portions of the subject is in the course of preparation. G. A. B.

OUR BOOK SHELF.

Man and the Glacial Period. By G. Frederick Wright, D.D., LL.D., F.G.S.A. (London: Kegan Paul, Trench, Trübner and Co., 1892.)

The title of this book raises expectations which the contents fail to satisfy. Out of 374 pages only sixty are devoted to the consideration of "the relics of man in the Glacial Period," and the treatment of the subject is, to say the least, uncritical. The reader does not learn from Prof. Wright that strong doubt has been expressed as to whether some of the "finds" of human relics in North America were really made in undisturbed glacial deposits, while his discussion of the European evidence is crude and inadequate, not to say misleading. The author has apparently only a slight acquaintance with the literature of the subject, acquired chiefly from such recondite sources as Lyell's "Antiquity of Man," and treatises on general geology. Of the many interesting facts bearing on man's relation to the Ice Age which have been discovered since those works were published our author is apparently ignorant. Nor has "a summer spent in Europe" sufficed, as who could expect that it should, to make up for his other deficiencies. Fortunately, the major portion of his volume deals with the glacial phenomena of North America, for here he is on safer ground. We feel sure, however, that many of his statements and conclusions will receive scant support from geologists across the water. It would be interesting to know, for example, what evidence can be adduced to show that the southern part of the United States was submerged during the Glacial Period to the extent of 500 feet, so as to bring the waters of the Gulf of Mexico into Illinois and Indiana. Again, we were under the impression that the author's "Ohio Lake," which he supposes came into existence when the great ice-sheet advanced into that region, had been effectually disposed of by Mr. Leverett and Prof. Chamberlin. Throughout the book the unity of the glacial period is confidently upheld, a view which Prof. Wright is, of course, entitled to maintain; but he might have informed his readers that with few exceptions American geologists are quite of another opinion. He fails to understand the evidence adduced by Chamberlin and others in favour of the periodicity of glaciation, while so far as one can gather from his pages, he seems to know nothing of the facts bearing on this question which geologists in Europe have accumulated, especially during the past few years.

Altogether we much prefer the author's earlier work, "The Ice Age in North America," of which the present is more or less of an abstract. In the former the facts of American glacial geology were given in considerable detail, and the writer's crude speculations and hypotheses were less obtrusive. Should the present work come to a second edition we would advise Dr. Wright to get some scientific friend to assist him in its revision. Loose unscientific phraseology and incorrect definitions are of not infrequent occurrence throughout the volume. Thus we read of "glacial ice," of "beautiful crystals of porphyry," &c., and are told that névé is the "motionless part" of a glacier, although a little further on we learn that it is from this "motionless" névé that "the glacier gets both its supply of ice and the impulse which gives it its first motion." Obviously Dr. Wright is unacquainted with the observations of MM. Pfaff, Kloche, and Koch on the movement of névé, while he might increase his knowledge of glacier motion by studying what Messrs. McConnel and Kidd have to say upon that interesting subject.

Beetles, Butterflies, Moths, and other Insects. By A. W. Kapple and W. Egmont Kirby. (London: Cassell and Co., 1892.)

This work is a slight sketch of the more prominent British insects, intended for youthful and very inexperienced entomologists. The first section is devoted to classification, the key to the orders of insects being a fairly workable one, though it takes no account of the very numerous exceptions. Then follows a section on structure, in which when describing the eye the authors ignore the latest experiments on the subject, proving that the compound eyes form but a single image of the object seen; they also treat the tongue or proboscis as if it were homologous throughout the orders, whilst in lepidoptera it is developed from entirely different organs from what it is in the others, except in the very lowest family; and again when describing the legs they fall into the almost incredible error of speaking of the first joint as the trochanter, saying it is joined to the thorax by a hinge-

plate, the coxa, the first joint being in fact the coxa and the trochanter, the short joint articulating it to the femur. Then follow short sections on the metamorphoses of insects and their habits and haunts, and longer sections on the collecting and preserving of perfect insects and larvæ, which are far more correct than the preceding ones, though very slight and quite insufficient for the initiation of a beginner. The main part of the book is devoted to short descriptions of the more prominent British insects under their various orders and families, and illustrated by twelve coloured plates, which are decidedly good for cheap chromographic work; this is by far the most useful portion of the book, and well-marked forms will easily be recognized from the figures and descriptions, even though many species are placed in their wrong families.

Ostwald's Klassiker der Exakten Wissenschaften. Nos. 31-37. (Leipzig: Wilhelm Engelmann, 1892.)

WE have already called attention to this admirable series of small volumes. It consists of scientific papers which may be said to have marked definite stages in the development of science. The only fault we have to find with the series, as we have already stated, is that only the German papers are given in the language in which they were originally written. All the others are translated. This is undoubtedly a mistake, for much may often depend on the precise words used by a great master of research. In other respects the series is excellent, and should be of genuine service to scientific students. The papers reproduced in the present set of volumes are Lambert's "Photometrie," three volumes (1760); photo-chemical researches, by R. Bunsen and H. E. Roscoe (1855-59); an attempt to find the definite and simple conditions in accordance with which the constituent parts of inorganic nature are connected with one another, by Jacob Berzelius (1811-12); on a general principle of the mathematical theory of induced electrical currents, by Franz Neumann (1847); observations on the moving power of fire and the machines fitted for the development of this force, by S. Carnot (1824).

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

"Aminol, a True Disinfectant."

WILL you grant me space, in order to avoid misunderstanding, to make the following explanation?—

(1) I recently learned that certain samples marked "Aminol, a true disinfectant" have been sent to various gentlemen, accompanied by a leaflet, in which my name, without my authority, is associated with those samples. Allow me to inform your readers that those samples contain "aminol" in water in the strength of one in five thousand. Now, the experiments which I carried out with "aminol," as regards its disinfecting power of microbes, were made with a solution of the strength of one in six hundred, and the disinfecting power of this strength was the following: spores of *Anthrax bacilli* remained unaffected after eight hours' exposure, only after an exposure for twenty-four hours did the number of living spores decrease, but some escaped disinfection even after so long an exposure. *Anthrax bacilli*, *Staphylococcus aureus*, and others were destroyed, but only after a prolonged exposure.

(2) A substance is advertised and circulated under the name of "Periodate crystals," and is associated with my name without my authority. Until quite recently I have made no experiments with it. A few years ago I made a few experiments, merely of a tentative character, with a solution which was labelled "Periodate," but not with the substance advertised as "Periodate crystals." With these latter I have recently made experiments, and I find that their solution in full strength has no disinfecting power on microbes, pathogenic and non-pathogenic, amongst which may be mentioned the bacillus and spores of anthrax, the bacillus of typhoid and of diphtheria, of cholera and of erysipelas, the *Bacillus prodigiosus*, the *Staphylococcus aureus*, and others. Likewise I find that injection of large quantities of the solution into guinea-pigs already infected with anthrax or diphtheria, has no power whatever in arresting or altering the normal course of these diseases to their fatal issue.

E. KLEIN.

Tracery Imitation.

I TOOK occasion some months ago to publish the result of observations on my child H.'s progressive attempts at drawing after outline "copies" set before her.[1] Examination of the series of her drawings made almost daily during the period from her nineteenth to her twenty-seventh month showed in them no apparent form or shape. They are simply vigorous pencil markings, answering as well to one "copy" as to another—or to none. Quite suddenly, however, in her twenty-eighth month, she seemed to catch the idea of breaking the "copy" (man) up into parts, and succeeded in making head, body, arms, legs, &c., in sufficient degree of relative proportion to show that here was, in her case, the rise of what I called in the article cited, "tracery imitation" of a visual picture.

At that time I had no explanation to offer, but simply recorded the observation. I have now, however, reached a way of explaining the rise of this apparently abrupt connection between muscle-sense and sight—an explanation suggested to me by a passage in Stricker's argument for the eye-movement theory of the visual apprehension of figure or outline.[2]

Before a child begins to acquire "tracery imitation," his drawings have no shape, but they show uniformly certain systems of angles, curves, &c., due to the easiest and most natural movements of the arm. The eyes, however, have been in a measure already educated to recognize certain shapes or "copies." There are, therefore, in consciousness two series of associations—one of eye-movement sensations, a, a^1, a^2, a^3, a^4, &c., with a certain strength of revival, which we may call x: the other, an associated series of arm-movement sensations, n, n^1, n^2, n^3, n^4, &c., representing a path of least resistance in arm movement. Let us call its strength or degree of tendency to progressive revival y.

Now, before the rise of "tracery imitation" y is greater than x, for the reason that the arm is restricted to a very few movements, and these are largely automatic. Once start one of these movements, and the tendency to carry it out is very strong. The tendency of the eye-movement series, on the contrary, to regular revival is slight; very few objects, copies, &c., being so clear and isolated as to give frequent unbroken reproductions. Consequently, the arm-movement series, n, n^1, n^2, &c., wins the day, and an abortive "drawing" is the result.

But the time comes soon when the reverse is true—when x is greater than y. The eye-movement series gets strengthened constantly by the repeated exploration of familiar figures, especially if, as in the case of my child, the eye be trained by having the same "copies" set from day to day. On the other hand, the arm and hand movement series gets constantly lesser and weaker, since the increasing mobility of the muscles, in the varied new activities of this period of infancy, is acquired at the direct expense of the early "cast-iron" reactions which are largely organic. Both of these tendencies were very marked in H.—the first, in the more pronounced recognition of the "copies" set before her; the second, in the less uncouth manner of holding her pencil, moving the fingers, disposing the arm, &c. Hence, it is simply a matter of education that x should soon overweigh y, and the elements of the eye series a, a^1, a^2, a^3, &c., should draw after them the arm series.

An association thus begins to be formed between the several members of the a series and certain correct elements of arm sensation: these latter go to form, under this leading, a new n series, which gradually becomes independent as an acquisition. That each new tracery combination is thus learned separately is seen in the fact that after H. learned to trace certain "copies" (man, bird), she was yet entirely unable to trace any others.

[1] *Science*, New York, January 8, 1892.
[2] "Du Langage et de la Musique" (French ed.), chap. xxii.; see also his "Studien über die Association der Vorstellungen."

She was even unable to trace a circle, except as part of a man (the head).

In a paper presented at the London meeting of the International Congress for Experimental Psychology last August, I insisted that voluntary movements are possible in the child only after a great variety of motor "elements" have become available through great diffusion and mass in involuntary (imitative) reactions.[1] The above phenomenon, thus explained, serves to illustrate the broader position.

As there is no literature on this subject, the question of "tracery-imitation" has not even been put before, to my knowledge, I should be glad to have opinions upon it. It is evident that if one hold the other theory of the visual apprehension of figure, *i.e.* that it is given by sight apart from sensations, of eye-movement, he could still hold the explanation which I have offered above, by substituting for the series of eye-movement sensations, a, a^1, a^2, &c., a series of visual sensations, v, v^1, v^2, &c. J. Mark Baldwin.

Difficulties of Pliocene Geology.

Considering the very great importance which the later tertiary beds must occupy in all speculations about the origin of man and the present geographical distribution of plants and animals, it is unfortunate that they should have attracted so little attention among English geologists.

The fact is perhaps not unnatural when we consider how very scantily they are represented in this country; the Norwich Crag being virtually the only bed where remains of pliocene land animals have occurred. The Norwich Crag is itself a very puzzling bed, where marine remains and land remains are found mixed together, the whole having been reassorted, and I do not know of a single pliocene land surface remaining intact in Britain. The so-called forest-bed can no longer be classed as pliocene, but is clearly of pleistocene age. A real mark of the true pliocene horizon in Europe is the occurrence of the mastodon and its associated fauna.

If we are to use the mastodon as a test we shall have to travel southward as far as Auvergne, if we are to find a pliocene land surface *in situ*. Unfortunately Auvergne is a very dislocated and broken country, and the sequence of the later deposits is very hard to make out, and I much question whether it be possible to find sections showing the true reading of the beds in question nearer than Florence.

I am writing in the hope that I may persuade Dr. Forsyth Major, who knows the valley of the Arno so well, to communicate to Nature some account of the results arrived at by the Italian geologists.

At present the question is one of great perplexity. Let me refer to two points. First, How comes it that in no part of the world, so far as I know, has a single fragment of an undoubted pliocene beast been found in a cave? The carnivora of pliocene times must have frequented caves just as much as the bears and hyenas of pleistocene times, yet how comes it that we can nowhere find any tertiary remains in any cavern? It will not do to appeal to denudation, for if there be deposits anywhere protected from denudation it is those in caves. Can it be that every mountain chain where limestone rocks occur is younger than pliocene times?

Again, we know that in America, both north and south, the mastodon survived to the end of the Pleistocene age, and lived alongside of the mammoth and the Columbian elephant. In Europe there is very great doubt whether the mastodon and any form of elephant were ever contemporaries. No doubt the teeth of the mastodon have been found with those of the elephant in the Crags, but the Crags have been so rearranged that it is impossible to draw any safe conclusions from them. It is at all events extraordinary that, according to the French geologists, the two beasts have never been found together in France. I believe the same conclusion has been arrived at by the Italian geologists, but upon this point there is some uncertainty, and it would be very interesting to have the opinion of so competent an authority as Dr. Forsyth Major upon the point. It is one of importance, for upon it depends largely the question of whether there was a continuity in Europe between the pliocene and pleistocene land, or whether, as I am disposed to believe, there was a break between the two involving perhaps a violent revolution. There are other interesting questions involved in the issue I have raised, upon which you may possibly permit me to write on another occasion. Meanwhile the burden of my present letter is to point out how little we really know about the pliocene land, and how useful it would be to know more. Henry H. Howorth.

The Athenæum Club, December 5.

[1] An abstract of the paper is to be found in *Science*, November 18, 1892, and also in the Proceedings of the Congress.

Meteors.

A fine meteoric shower was observed here on the night of November 23, from 7h. 30m. to 12h. 30m., when the observations were interrupted by cloud.[1] The meteors were evidently "Bielids," the radiant at 8.30 being near a point, R.A., 1h. 20m.; Dec., 40° 30′. The radiant, however, was not well defined, its area being at least 4° in diameter. For a single observer, in a position which commanded only about one-sixth of the visible hemisphere, the meteors numbered about six a minute, which would indicate at least seventy-five a minute for the entire sky, exhaustively observed.

At ten o'clock two observers, standing back to back in an open space, counted 104 meteors in five minutes; the position of the radiant being then, R.A., 1h. 30m.; Dec., 41° 30′—very near Upsilon Andromedæ. At this time the radiant seemed to be rather more definite than earlier, and several nearly stationary meteors determined the place with reasonable precision.

An hour later a similar count by the same two observers gave 100 meteors in four minutes and a half, and the radiant was determined at R.A., 1h. 40m., Dec., 40°. The rate of frequency continued about the same until the sky clouded up an hour later, and must, I think, be estimated as high as from 80 to 100 a minute for the whole number that might have been seen by a sufficient corps of observers. This would foot up from 24,000 to 30,000 for the five hours.

I am not quite certain whether the apparent change in the position of the radiant is, or is not, real; but a motion very similar in amount and direction is given by Denza in his observations of the meteoric shower of 1885 (see Nature, vol. xxxiii. page 151).

Comet "*f*" (Holmes's) was about 10° west and 4° south of the mean radiant at R.A., 0h. 40m., Dec., 360° 45′. It was barely visible to the naked eye.

Most of the meteors were very small, not exceeding the fifth magnitude; but a few, perhaps one in ten, were above the second, and in the course of the night four were seen which rivalled or surpassed Jupiter. The brighter ones left bluish trains, which remained visible for three or four seconds. The smaller ones often came in "flights" of three or four together, and fully half the paths were more or less curved and wavy from the resistance of the air.

It is worthy of notice that the heliocentric longitude of the earth at the time of the shower was about 62°, instead of 65° which was the longitude of the descending node of Biela's orbit at the last appearance of the comet in 1852, and was the longitude of the earth at the time of the showers of 1872 and 1885. The fact suggests the inquiry whether perturbations since 1885 will fairly account for such a recession of the node.

It is obvious also that if the meteoric swarms encountered by the earth in 1872 and 1885 were really moving in the orbit of Biela's comet (which at its last appearance had a period of 6·6 years), then the swarm encountered the other night, just seven years later, must have been an entirely different one—unless indeed the perturbations since 1885 can account for a retardation of nearly five months.

Last night was for the most part overcast, but a watch of fifteen minutes through occasional openings in the clouds showed only one or two possible Bielids. Evidently the shower was not continuing with any intensity. C. A. Young.

Princeton, N.J., U.S., November 25.

Comparative Sunshine.

After explaining that by "sunshine" I intend that which *would* fall upon the earth if there were no atmospheric obstruction, one must first notice the very elementary truth that the amount of such sunshine at any assumed time and place is in proportion to the altitude of the sun at noon, and also the

[1] Our "Eastern standard time" is just five hours slower than Greenwich time.

length of the day. Except at the time of the equinox, the gradual lengthening or shortening of the day, as the solstice is approached, most materially affects, especially in the higher latitudes, the total amount of sunshine received in twenty-four hours.

But are there any convenient and readily accessible tables—as there easily might be—which would at a glance show numerically the comparative amounts of sunshine at certain selected times and places? I would wish to see such tables, say, for every tenth day, for the three months from an equinox to a solstice, for about every third degree of latitude in each hemisphere. I see not how, without this, either the causes or the effects of meteorological changes in different regions at different seasons can be justly estimated. I would propose to express the amount of sunshine during twelve hours at the equator at the equinox by, say, 100; the figures rising above this, or falling below it. Thus there would be more than 100 given for the latitude of the Tropic of Cancer at the summer solstice, with a vertical sun and more than twenty-four hours' sunshine; with 100 for a latitude still further north. REGINALD COURTENAY.

The Imperial Hotel, Sliema, Malta, November 14.

Quaternions.

BY the kindness of the author I have just received a copy of Mr. Heaviside's paper "On the Forces, Stresses, and Fluxes of Energy in the Electromagnetic Field" (*Phil. Trans.*, 1892, p. 423), in which he reopens a question debated in your columns some time ago—the question of Quaternions *versus* other methods of vector analysis for the use of physicists.

At present the matter stands thus:—There are two widely-known systems of vector analysis before the public—Quaternions and the Ausdehnungslehre—and quite a multitude of less known ones, of which Prof. Gibbs's seems to be one of the least open to objection, and of which, in my opinion, Mr. Heaviside's is by no means so. It would take too long, however, to justify this opinion, but I wish to make an appeal to Mr. Heaviside and Prof. Gibbs on grounds independent of the merits or demerits of their particular systems.

Of the Ausdehnungslehre I do not feel competent to speak. As to Quaternions, there are undoubtedly some inconveniences in physical applications, and I am quite willing to concede that a grave one is the very frequent use of the letters S and V (Mr. Heaviside uses the latter). I do not regard the sign of the scalar product which vexes the soul of Mr. Heaviside as of any consequence. But while thus admitting that a better system than Quaternions is conceivable, I think I can show that the position of the dissenters is little short of suicidal.

The band of physicists who use and urge the use on others of vector analysis is woefully small. Let me put a question to two of the justly best known of that band, Prof. Gibbs and Mr. Heaviside. What is the *first* duty of the physical vector analyst *qua* physical vector analyst? I think I may anticipate that the answer will be—to convince the world of mathematical physicists that vector analysis must be unshelved and set to work. The next question that arises is one of tactics. What should be the plan of campaign to bring this desirable result about? Here I am afraid we cannot hope for unanimity even among the members of the small band, and this is to be most grievously deplored. But surely every sane man will agree that what most certainly the analysts should not do is to present their arguments to those they would convince in a dozen different mathematical languages, each of which is puzzling enough to those learned in allied languages. Grant this, and it follows that Quaternions and the Ausdehnungslehre should be left in sole possession of the field. The day for Prof. Gibbs's improvements is not yet. Prof. Gibbs and Mr. Heaviside have not yet convinced the rest of the small band—not to say each other—of the merits of their algorithms. Let me implore them to sink the individual in the common cause, and content themselves with the faith that posterity will do them justice.

Apart from the question of notation there seem to be two schools of opinion as to the proper conduct of the campaign. To vary the metaphor, Maxwell, Clifford, Gibbs, Fitzgerald, Heaviside prescribe a course of spoon-feeding the physical public. Hamilton and Tait recommend and provide strong meat. I do not think that harm, but rather good, will come from this double treatment, as one course will suit some patients and the other others. *But* let the spoon-feeders provide spoon-meat of the same *kind* as the other physicians. Is not Maxwell, Clifford, and Fitzgerald's food as digestible as Prof. Gibbs's and Mr. Heaviside's? ALEX. MCAULAY.

Ormond College, Melbourne, October 31.

Animals' Rights.

MR. SALT disputes the justice of the statement that he has given two contradictory definitions of animals' rights, inasmuch as, according to him, that which he has set forth on p. 28 is but a repetition and amplification of the one to be found on p. 9.

By the definition on p. 9 animals' rights are said to consist in a "due measure" of the restricted freedom which constitutes the right of man, *i.e.* (as Mr. Salt notes) the freedom "to do that which he wills, provided he infringe not the equal liberty of any other man"—"a restricted freedom" which guarantees to the harmless individual *the security of his life and liberty.*

But on p. 28 the rights of animals (which were said before to consist in a "due measure" of that just quoted) being here stated to be "subject to the limitations imposed by the permanent needs and interests of the community," are found to be burdened with so serious a qualification that *security for the life and liberty of the harmless individual is by it completely destroyed.*

A European might settle with confidence in an unknown island, on the assurance that he would be allowed a measure of the general right of the natives to the freedom to do that which they would, provided they infringed not the equal rights of any other, but were he afterwards to discover that the "measure" of this right which was considered to be the "due" of a foreigner was in reality limited "by the needs and interests of the community," and that, a community where the custom of enslaving and eating strangers had existed from time immemorial, we venture to assert that his departure from the island would be effected with as little delay as possible. We should much regret misrepresenting Mr. Salt's statements, but the assertion that the second definition of rights is but a repetition and amplification of the first is manifestly untenable, and if, by "*due measure*" for animals of the rights of man, Mr. Salt would have us understand that he meant—only such a measure as is consistent with the nullification of the most fundamental privileges secured by them, he must have been discussing the subject in a vein of sarcasm which we are bound to confess we had quite failed to appreciate.

THE REVIEWER.

The Height and Spectrum of Auroras.

THERE was a magnificent aurora on the evening of the 4th, part of which, from 10h. 46½m. to 48m. or 49m., was an intense red. I noted the positions of some of the features at the exact half-hours and also at some other times, for comparison with any observations that may have been made in other places, for ascertaining the height of the phenomenon; and I hope some such observations have been made of the recent display, and will be made of further ones in the future, for Dr. Veeder, of Lyons (New York), has kindly consented to calculate the heights from the observations.

I am surprised that none of our persevering photographers have as yet obtained a good photograph of the auroral spectrum. I do not think it would be more difficult than the stellar photographs that have been taken, seeing that the exposure might go on for hours. It would be desirable to have it done with a camera that could be pointed in any direction at will, so that wherever the observer saw a bright portion of the aurora he could direct the instrument to it. T. W. BACKHOUSE.

Sunderland, December 6.

The Teaching of Botany.

THERE appeared in NATURE (vol. xxxi. p. 229) a paper entitled "Experiments suitable for illustrating Elementary Instruction in Chemistry," by Sir H. E. Roscoe and W. J. Russell. I have long felt the want of a similar series of experiments in physiological botany. There is not much difficulty in teaching the morphological side of the subject, but it is not easy for the ordinary high-school teacher to devise and carry out a suitable series of experiments for demonstrating the more important aspects of physiological botany. If some master in the

subject would do for botany what Sir H. E. Roscoe has done for chemistry he would confer a great boon on teachers and young students. A. H.

Egyptian Figs.

MY attention has been called to a very obvious slip of the pen in my note on Egyptian Figs, in that I have written "Pliny" instead of "Theophrastus." The former, as all know, was a *Latin* author, but he simply copies from the latter. Having both authors before me at the time, I accidentally put one name for the others. The refs. are as follows:—Theoph. iv. 2; Dioscor. l. 1; Plin. xiii. 7. GEORGE HENSLOW.

A Palæozoic Ice-Age.

I CANNOT understand how, when writing on this subject *ante*, p. 101), I overlooked the circumstance that the ancient boulder-beds of Australia, India, and South Africa received full notice in Prof. J. Prestwich's "Geology," vol. ii. pp. 143–146.
December 9. W. T. BLANFORD.

SCHEELE.

DURING this month Sweden commemorates the one hundred and fiftieth anniversary of the birth of one who has conferred an imperishable lustre on her annals. Carl Wilhelm Scheele—although a German by nationality, for he was born at Stralsund, the capital of Pomerania—spent practically the whole of his short life in Sweden, and is usually regarded as a Swede. The son of a tradesman, Joachim Christian Scheele, and the seventh child of a family of eleven, Scheele, as a boy, gave little promise of the genius and power which astonished the scientific world towards the close of the last century. It is perhaps indicative of a certain mental imperfection that he should have been wholly incapable of learning a foreign language; although he lived in Sweden during more than half his life his knowledge of Swedish was so imperfect that his memoirs, addressed to the Academies of Stockholm and Upsala, were invariably written by him in German and had to be translated by others before publication. By what influences he was led to the study of chemistry is unknown. There was nothing apparently in his home life, or in the mode or circumstances of his education to direct his inclination towards science. As a boy he began the study of pharmacy, and at his own wish was apprenticed to an apothecary at Göteborg named Bauch, with whom he remained eight years. Here he had access to the standard treatises on chemistry of that time, and he devoted all his leisure, often working far into the night, to the study of the works of Neumann, Lemery, Kunkel, and Stahl. Kunkel's Laboratorium was, indeed, his chief instructor in practical chemistry, and it was by diligently repeating, in the first instance, the experiments contained in that book that he acquired that extraordinary manipulative skill and analytical dexterity on which his success as an investigator ultimately rested.

When twenty-three years of age Scheele removed to Malmö, and some years afterwards to Stockholm, where he superintended the shop of an apothecary named Scharenberg. It was about this time that his career as a discoverer began, by the isolation of tartaric acid from cream of tartar. He ascertained many of the characteristic properties of this acid and prepared and examined a number of tartrates. These early efforts met, however, with a somewhat untoward reception. It seems that Scheele drew up an account of his observations and forwarded it to Bergman, who then filled the chair of chemistry in the University of Upsala as the successor of Wallerius. Bergman failed to appreciate the significance of the work of the young and unknown apothecary and by some mischance the manuscript was lost. The importance of the discovery was, however, recognized by Retzius, who induced Scheele to write a second account of his work and to submit it to the Academy of Sciences at Stockholm, by whom it was eventually printed. In 1771 Scheele published his memorable essay, "On Fluor Mineral and its Acid," in which he first demonstrated the true composition of fluor-spar, showing that it "consists principally of calcareous earth saturated with a peculiar acid," named by him "fluor-acid." Although he found that the "fluor-acid" (hydrofluoric acid) dissolved "siliceous earth," he failed to recognize the change thereby produced in the "fluor-acid" and was thus led to an erroneous conception of its real nature. He was in fact led astray by the circumstance that his experiments were for the most part made in glass vessels, and hence the fluor-acid was contaminated with more or less silica and hydrofluosilicic acid. The origin of the silica in the acid prepared by Scheele was first clearly indicated independently by Wiegleb and Meyer. In 1773 Scheele went to Upsala as pharmaceutical assistant to Mr. Lokk, in whose shop he chanced to meet the chemist Gahn. Lokk and Gahn were speculating on the cause of the different mode of action of distilled vinegar on nitre before and after fusion. This was explained by the young assistant, who pointed out the nature of the change effected on nitre by fusion; and the fact that it is converted into a salt (potassium nitrite) from which a peculiar acid, different from true "spirit of nitre," can be obtained by treatment with distilled vinegar. Gahn, struck with the sagacity of the young pharmacist, offered to introduce him to Bergman. The invitation was at first declined; Scheele had not forgotten the unfortunate incident of the tartaric acid memoir. Eventually he allowed himself to be convinced that Bergman's action was due more to inadvertence than to indifference, and the acquaintance which followed rapidly ripened into a strong friendship. In 1774 Scheele, at the suggestion of Bergman, published his well-known memoir "On Manganese, Manganesium, or Magnesia Vitrariarum." This essay, although marred and in part obscured by the phlogistic conceptions of the period, will for ever remain one of the classics of chemistry. In it Scheele not only established the nature of "pyrolusite" or "wad," but, in studying the action of acids upon the mineral, he was led to the discovery of baryta and of chlorine, the properties of which he minutely describes. In 1775 appeared his memoir on arsenic acid which he prepared in several ways; he discovered many of the more striking properties of this body and obtained a number of its salts. In the course of the investigation he discovered arseniureted hydrogen, and the well-known pigment Scheele's Green. In the same year he published his essay on benzoic acid, the "flowers of benzoin" of the apothecary. After a stay of two years in Upsala Scheele was appointed by the Medical College *provisor* of the pharmacy at Köping, a small town on the north shore of Lake Mälar. Instead of the prosperous business he had been led to expect he found nothing but discomfort and disorder, and the remainder of his life was spent in a constant struggle with privation and debt, relieved at length, to some extent, by a grant, at Bergman's instigation, from the Stockholm Academy. Of this money Scheele set aside one-sixth for his personal necessities, and devoted the remainder to his researches. In 1777 he took over the business of the pharmacy from the widow of the former proprietor, but it was only by unremitting industry that he was able to discharge the obligation he thereby incurred. Not a year passed, however, without Scheele publishing two or three memoirs, every one of which contained a discovery calculated to enhance his reputation as the greatest experimenter of his time. This untiring devotion to science at length began to tell upon a frame constitutionally weak and doubtless further enfeebled by privation, and by the worry

of debt and difficulties. He struggled on, however, a martyr to rheumatism and suffering from a complication of internal disorders until he was struck down in the spring of 1786. Some time before his fatal illness he had formed the resolution of marrying the widow of his predecessor so soon as his circumstances should permit: on his death-bed he carried out this project, bequeathing to his wife such property as he had been able to acquire. Two days afterwards (May 21, 1786) he died at the age of forty-four.

The eleven years during which Scheele lived at Köping were fruitful in investigations of the highest importance in every department of chemistry. In that time he discovered molybdic, tungstic, and arsenic acids among the inorganic acids; and lactic, gallic, oxalic, citric, malic, mucic, and uric among the organic acids. He also discovered glycerin, determined the nature of Prussian blue, and prepared hydrocyanic acid. He demonstrated that plumbago is nothing but carbon associated with more or less iron, and that the black powder left on the solution of cast-iron in mineral acids is essentially the same substance. He determined the chemical nature of sulphuretted hydrogen, discovered arseniureted hydrogen, and invented new processes for preparing ether, powder of algaroth, calomel, and *magnesia alba*. He made numerous analyses of air by absorbing the oxygen with a mixture of iron filings and sulphur. He concluded that "our atmosphere contains always, though with some little difference, the same quantity of pure or fire air [oxygen] viz. $\frac{9}{33}$ which is a very remarkable fact; and to assign the cause of it seems difficult, as a quantity of pure air [oxygen] in supporting fire, daily enters into a new union; and a considerable quantity of it is likewise corrupted or changed into aerial acid (carbon dioxide) as well by plants as by respiration; another fresh proof of the great care of our Creator for all that lives."

Scheele's greatest work, however, is unquestionably his treatise on "Air and Fire," which appeared in 1777 with a preface by Bergman, who, according to Thomson, superintended its publication. This elaborate essay shows Scheele at his best and at his worst; it testifies to his genius as an experimentalist and to his weakness as a theorist. No one can read this, or indeed any other of Scheele's memoirs, without being impressed by his extraordinary insight, which at times amounted almost to divination, and by the way in which he instinctively seizes on what is essential and steers his way among the rocks and shoals of contradictory or conflicting observations. No man was ever more staunchly loyal to the facts of his experiments, however strongly these might tell against an antecedent or congenial hypothesis. Had Scheele possessed that sense of quantitative accuracy which was the special characteristic of his contemporary Cavendish, his work on "Air and Fire" would inevitably have effected the overthrow of phlogistonism long before the advent of Lavoisier. His memoir is essentially an essay on oxygen, of which he was an independent discoverer, in its relations to life and combustion. It is perhaps idle to speculate on the causes which prevented his clear recognition of the full truth. It may have been that he was essentially a *preparateur* like Priestley, and that quantitative chemistry had few attractions for him; it is far more probable that the character of his work was determined by the circumstances of his position, by his poverty, his lack of apparatus, and his want of assistance. As it is, it remains one of the most remarkable circumstances in the history of human knowledge that a man working under such adverse conditions in a small village on the shore of a Scandinavian lake should have been able to change the entire aspect of a science.

It was stated by Crell, the editor of the well-known *Neue Entdeckungen* and *Annalen*, in which many of Scheele's papers first appeared, that the great Swedish chemist was invited to this country with the offer of an easier and more lucrative position than that which he had at Köping; but that his partiality for Sweden and his love of quiet and retirement delayed his acceptance of the offer until a change in the English ministry put a stop to the negotiations. Thomson, the author of the "History of Chemistry" in mentioning this circumstance, expresses his doubts as to its truth, and states that he made enquiries of Sir Joseph Banks, Cavendish, and Kirwan, but none of them had ever heard of such negotiation. Indeed the circumstance is intrinsically improbable. "I am utterly at a loss," says Thomson, "to conceive what one individual in any of the ministries of George III. was either acquainted with the science of chemistry or at all interested in its progress. . . . What minister in Great Britian ever attempted to cherish the sciences, or to reward those who cultivate them with success? . . . If any such project ever existed, it must have been an idea which struck some man of science that such a proposal to a man of Scheele's eminence would redound to the credit of the country. But that such a project should have been broached by a British ministry, or by any man of great political influence, is an opinion that no person would adopt who has paid any attention to the history of Great Britain since the Revolution to the present time."

T. E. THORPE.

WERNER VON SIEMENS.

ERNST WERNER SIEMENS was the eldest son of Christian Ferdinand Siemens and Eleonore Deichmann; he was born in 1816 at Lenthe in Hanover, where his father was engaged in the business of agriculture and forestry.

From his very childhood the subject of this memoir learnt the lessons of self-control and responsibility, for owing to his mother's delicate health and his father's occupations, the care of his younger brothers and sisters devolved on himself and his sister Mathilde; in these younger days he also learnt tact, and his father taught him that difficulties had to be faced and overcome, and that duties must never be avoided.

In 1823, a few months after the birth of his brother William (whose lamented death occurred here nine years ago), the family removed to Menzendorf near Lübeck, in the Grand Duchy of Mecklenburg. In the Gymnasium of Lübeck Werner was educated up to his eighteenth year, when, by the advice of his father—who with rare prescience saw in Prussia the nucleus of German Unity and Empire—he went to Magdeburg to volunteer for service in the Prussian Army. For three years he studied in the Military School of Berlin, and in 1838 received his commission as a lieutenant in the artillery, and returned to Magdeburg; he was soon transferred to the Technical Division of the Artillery at Spandau, and afterwards to Berlin.

In July, 1839, his mother died, and six months afterwards his father; and then, at only twenty-three years of age, he became the veritable guardian of his younger brothers and sisters.

In 1842 he took out a patent in Prussia for electroplating and gilding, and having established a factory in Berlin for putting his invention into practice, he urged his brother William to devote his attention to the subject. This the younger brother did; and the story of his enterprise and success in this country then and ever since has been told by Dr. William Pole in his most interesting biography of him; to this volume and to the works of Dr. Werner von Siemens, the first volume of a translation of which has recently been published by Mr. Murray, we are indebted for much of the information contained in this short notice.

In 1844 the young artillery officer was appointed to the important post of Superintendent of the Artillery workshops, and in 1847 he became a member of the commission then instituted for introducing the electric telegraph into Prussia. Next year his military duties called him to Kiel, where in conjunction with his brother-in-law, Prof. Himly, he protected that port against the attack of the Danish fleet, by means of submerged mines connected with the shore by cables, at once the precursor of the submarine cable and the torpedo. In the summer of 1848, as commandant of Friederichsort, he built the fortifications for the protection of the harbour of Eckenförde, which afterwards became so celebrated. In the same year he was recalled to Berlin in order to erect a line of telegraph from Berlin to Frankfort-on-the-Maine, the first electric line laid in Germany, and with this his official military career terminated, and he devoted his attention altogether to those scientific discoveries and

inventions which have made the name of Siemens a household word in every region of the globe.

In 1874 Dr. Werner Siemens was elected a member of the Royal Academy of Sciences of Berlin, and the speech he made upon that occasion enables one to understand and appreciate his connexion with physical science. He was professionally connected with the application of science, which unfortunately left him but little leisure for those purely scientific investigations to which he always felt specially attracted. He says, to quote his own words in the speech just referred to, "My problems were generally prescribed by the demands of my profession, because the filling up of scientific voids which I met with presented itself as a technical necessity. I will only here mention cursorily my method of measuring high velocities by means of electric sparks, the discovery of the electrostatic charge of telegraph conductors and its laws, the deduction of methods and formulæ for testing underground and submarine cables, as well as for determining the position of faults occurring in their insulation, my experimental observations on electrostatic induction, and the retardation of the electric current thereby, the conception and realization of a reproducible basis of measurement for electrical resistance, the proof of the heating of the dielectric of a condenser by sudden discharge, the discovery and explanation of the dynamo electric machine. I think I may claim that many of my technical contributions are not without scientific value, among which I may mention the differential regulator, the manufacture of insulated conductors by pressing gutta-percha around them, telegraphic duplex, diplex, induction and automatic recording instruments, the ozone apparatus, and measuring instruments of different kinds. I had the honour of seeing these recognized by receiving from the Berlin University the distinction of Doctor of Philosophy, *honoris causa.*"

The reply to this speech was made on behalf of the Berlin Academy by Prof. du Bois Reymond, the Secretary of the Physical and Mathematical Section, and some of the words he then spoke will show how Germany appreciated one of her ablest sons, one whom we also may claim, for when Werner Siemens was born, the King of England was Elector of Hanover. "By appropriating such a scientific form as yours, my dear Siemens, no Academy need be untrue to the laws of its foundation. Yours is the talent of mechanical discovery, which primitive people not improperly described as divine, and the cultivation of which constitutes the ascendancy of modern culture. Without having yourself worked with your hands in practical mechanics, you have reached the highest point in that art as creating and organizing head. With clear view and daring mind you soon grasped the great practical problems of electric telegraphy, and thus secured to Germany an advantage which Gauss, Wilhelm Weber, and Steinheil could not have procured for it. Your labours were for electricity what Frauenhofer's were for light, and you are the James Watt of electro-magnetism. Now you rule over a world which you created. Your telegraph lines surround the globe. Your cable ships navigate the ocean. Under the tents of nomads using bows and arrows, through whose hunting grounds your messages pass, your name is mentioned with superstitious awe."

This poetical description is fully justified by the great undertakings that have been carried out by the Siemens firm. The Indo-European telegraph, 2750 miles in length, passes across Europe, through a part of Russia to Tabreez and Teheran in Persia, and thence to India. But for the international character of the firm this work could probably never have been accomplished. But with Mr. Carl Siemens in St. Petersburg, Dr. Werner in Berlin, and Mr. William in London, to carry out the necessary negotiations, the tender was accepted in June, 1869, and the work was completed in December of the same year. Since then eighteen cables of a total length exceeding 21,000 miles have been constructed at their Woolwich works and laid in the Atlantic by the *Faraday*, by the firm of Messrs. Siemens Brothers and Co., Limited, of which firm Dr. Werner von Siemens was Chairman and Mr. Alexander Siemens is the Director in London.

In a single line of the speech just alluded to Dr. Werner refers to the dynamo machine. On this machine the whole supply of electricity for lighting, transmission of power, and other large purposes is dependent; and it is interesting in this connexion to note that the only rival to the electric light for large effects is the regenerative gas lamp invented by Dr. Werner's youngest brother, Mr. Frederick Siemens, the inventor, with Sir William Siemens, of the regenerative gas furnace.

Dr. von Siemens was a Knight of the Prussian order *pour le mérite*, an honour conferred only on those who have been distinguished for their services to science and industry. The honorary degree conferred upon him by the University of Berlin, and his membership of the

Royal Academy of Sciences of Berlin, have already been referred to. Dr. von Siemens was a member of many learned societies, and only in the spring of this year he was elected one of the sixteen honorary members of the Institution of Civil Engineers. The late Emperor Frederick III. of Germany conferred upon him the patent of nobility in 1888, and the present Emperor has expressed his sympathy with his sorrowing widow and family.

Dr. Siemens was unfortunately one of those attacked during the influenza epidemic, and although he recovered from it, it left him weak, and he has since been ailing more than once. A work on which he has been spending his spare moments was an autobiography, giving reminiscences of himself and of the firm of Siemens and Halske. This was published in Berlin a fortnight ago. On Tuesday, the 6th inst., Dr. Werner breathed his last at half-past six in the evening, just within a week of completing his seventy-sixth year. It may truly be said of him that, although he has passed from us, his life's labours will ever endure, having left an indelible mark on the world's progress.

The funeral took place on Saturday. The London, Belfort, Vienna, and St. Petersburg factories of the firm of which the deceased was a member, sent officials and workmen; the many thousands following the hearse, and the respectful attitude of the bystanders in the streets through which the funeral procession passed testifying to the regard in which he was held. The Emperor William was represented by Prince Leopold, the Empress Frederick by Count Seckendorff, and the German Empire by Chancellor Caprivi. Science and art and industry, the City of Berlin and the town of Charlottenburg were represented by deputies and deputations, all combining to do honour to one esteemed of all. E. F. B.

NOTES.

WE are glad to announce that Sir Archibald Geikie has undertaken to write the Life of Sir Andrew C. Ramsay, his predecessor in the Geological Survey. Sir Andrew Ramsay spent nearly the whole of his scientific career in the service, so that the record of his life and the story of the progress of the Survey are closely bound together. This is the third member of the staff of the Survey whose memoirs Sir Archibald Geikie will have written, the two others being Edward Forbes (whose Life he wrote in conjunction with the late Prof. George Wilson) and Sir Roderick Murchison. Sir Archibald joined the staff under Ramsay, and grew into the closest relations of friendship with him.

WE regret to have to record the death of Mr. H. T. Stainton, F.R.S. He died on December 2 at the age of seventy. He was indefatigable in his study of entomology, to which he made many important contributions. His chief work is "Natural History of the Tineina," in four languages, with many plates. His "Manual of British Butterflies and Moths" is also well known. Mr. Stainton was one of the founders of the *Entomologists' Monthly Magazine*, and remained to the end of his life one of its editors. He was for many years secretary of the Ray Society and of the Zoological Record Association, and one of the secretaries of Section D of the British Association. From 1848 he was a Fellow of the Entomological Society, of which he was at one time president; and from 1859 he was a Fellow of the Linnean Society, of which he was at one time vice-president. He was elected a Fellow of the Royal Society in 1867.

THE Chemical Society held a special meeting on Tuesday, the anniversary of the death of Stas. A paper, prepared for the occasion by Prof. J. W. Mallet, F.R.S., on "Jean Servais Stas, and the measurement of the relative masses of the atoms of the chemical elements," was read and discussed.

THE new Victoria buildings of University College, Liverpool, which include the Jubilee Tower, were formally opened on Tuesday. Lord Spencer, as Chancellor of the Victoria University, took part in the ceremony. At a banquet held in the evening, Mr. Bryce announced that the Queen, out of certain funds belonging to the Duchy of Lancaster, had been pleased to bestow upon the two great Lancashire Colleges a sum of £4000, to be applied in some permanent form, such as might be agreed upon by the authorities of the Colleges, particularly the principals, to commemorate the event of that day, and Her Majesty's interest in the growth of the institution.

ON Monday, at Merchant Taylors' Hall, Dr. William Anderson presented the prizes in connection with the City and Guilds of London Institute for the Advancement of Technical Education. Afterwards, addressing the students, Dr. Anderson called attention to the extraordinary advantages enjoyed by students of the present day in comparison with those within the reach of students of the past generation. In nearly all towns men and women were improving their knowledge in almost every branch of art and science to which their necessities or their inclinations led them. He had come to the conclusion that the aids given nowadays to manufactures and commerce were absolutely indispensable if England was to hold her own, and to overcome the difficulties which high-priced labour, the restrictions of the Legislature, and the interference of trade organizations imposed.

DR. T. JEFFREY PARKER, F.R.S., of Dunedin, Otago, New Zealand, who is now in this country, will read a paper on the cranial osteology, classification, and phylogeny of the Moas (Dinornithidæ) at the Zoological Society's meeting on the 14th of February.

THE committee appointed by the Board of Agriculture to inquire into the plague of field voles in Scotland have declined for the present to recommend the adoption of the plan lately carried out in Thessaly by Prof. Loeffler, who claims to have got rid of voles in that district by feeding them with prepared bait containing the germs of mouse typhus. It is thought that Prof. Loeffler may not have attached sufficient weight to other causes which have doubtless operated to reduce the swarms of voles in Thessaly, such as the heavy rains which on the low ground would flood the holes and runs of the mice. The chairman of the committee, Sir Herbert Maxwell, and the secretary, Mr. J. E. Harting, with the sanction of the Board of Agriculture and of the Treasury, are about to proceed to Thessaly for the purpose of taking evidence there and reporting.

A NEW edition of M. Alphonse Bertillon's important book on "Identification Anthropométrique" will be published in January. The book has been entirely recast and considerably enlarged. It is the result of ten years of observation, and has been prepared, not merely for the anthropometric service directed by the author, but for all who desire to have a proper comprehension of man's physical qualities. In addition to the copies intended for the use of the penal administration of the French Ministry of the Interior, a small number of copies will be reserved for persons who may desire to subscribe for them.

ON the evening of Thursday the 8th instant a deep barometric depression advanced upon our north-west coasts, and proceeded with considerable rapidity in a south-easterly direction, completely traversing Great Britain, as far as Dover, and travelling throughout its course at the rate of about 36 miles an hour. Its passage was accompanied by gales and by heavy rain or sleet, with severe snowstorms on the east coast. This disturbance passed away to the eastward, and was followed on Saturday by a fresh depression which appeared in the north-west, causing a strong gale in that district, and heavy squalls in most other parts. The changes of temperature were very

irregular, the air being warm and moist under the influence of the cyclonic systems, but cold and relatively drier in the rear of the disturbances; in Scotland the frost was at times severe, the lowest of the minima being as low as 8° in the east of Scotland. In the early part of the present week a temporary improvement took place, with a generally rising barometer and falling thermometer, but these conditions soon gave place to a fresh disturbance in the north-west, accompanied by south-westerly winds generally. The *Weekly Weather Report* for the period ending the 10th instant showed that the temperature was below the mean in all districts, the greatest deficiency being about 7° over the northern parts of the kingdom. Rainfall exceeded the mean in the north-west of England and the north of Ireland, but in all other districts it differed little from the average amount. Bright sunshine was more prevalent than for many weeks past, except in the north of Scotland, where only 5 per cent. of the possible amount was registered.

A FOREIGN OFFICE "Report on the Social and Economical Condition of the Canary Islands" (No. 246, 1892) contains some details with respect to the climate. There is no record of the freezing point having been touched at Laguna (Teneriffe), 1840 feet above the sea. At Vila Flor, also in Teneriffe, 4335 feet above the sea, the highest point where cultivation exists, the lowest temperature recorded in 1890–91 was 28°; the lowest reading at the sea level during the same period was 49°. The highest summer reading at Laguna was 104°·9 in 1885. The average maximum temperature near the sea in the summer is about 82°. The annual rainfall at Laguna is 29·4 inches, but at Santa Cruz (Teneriffe), at the sea level, it is only about 11 inches, and at Las Palmas it is as low as 8·4 inches. The greater part of the rain falls in the Monte Verde, where the vapour is carried from the sea by the trade wind. The rain generally begins early in October and ceases early in May.

THE country between the Nile and the Red Sea has not always been so barren as it is to-day. There is ample evidence that in former times bodies of cavalry from three to five hundred in number ranged without commissariat difficulties over districts which are now deserts. The Arabic names of the valleys are names for trees, and there can be little doubt that at one time the valleys abounded with the trees after which they were called. How is the change to be explained? Much light is thrown on the problem by a most interesting paper printed in the new number of the *Kew Bulletin*, to which it has been communicated by Mr. E. A. Floyer, F.L.S., Inspector-General of Egyptian Telegraphs. It is an extract from the report (which will be published in French by the Egyptian Government) of the expedition despatched by the Khedive to this region in 1891. The writer believes that the mischief has been done during the last twelve hundred years, and that it is to be attributed to the Arab and his camel; the camel having eaten the leaves and shoots of the trees, the Arab having converted into charcoal the stem, root, and branch. The writer is inclined to state the matter thus: So long as the valleys were all the Arab had to depend on for feeding his camels, so long he preserved his trees for his camels. But by degrees some Arabs got a footing in the Nile Valley. They hired their camels to the farmer to carry their harvest. They went back to their deserted valley and brought away the trees in form of charcoal. Thus the land was gradually made bare. If this explanation is correct—and there is evidently much to be said for it—the writer points out that a like cause may be invoked over large areas to explain, for example, the disappearance of the frankincense and spices from Southern Arabia, to explain the thousands of chariots and horsemen in Palestine, and to explain how in early times a greater fertility and population existed in many countries whose history, like that of Palestine, seems out of proportion to their present circumstances. It is a pity, by the way, that in so good a paper nature should be spoken of as having produced in the camel "a Frankenstein." Frankenstein in the story was not the monster, but the monster's creator.

IT is by no means certain that the harm which the camel is capable of doing in Egyptian territory has even yet been exhausted. The writer of the report considers it possible that the prosperity in Egypt in which all Englishmen are rejoicing may seal the destruction of the remaining trees, and leave the country bare save of *Calotropis procera* and the plants which nourish a few sheep and donkeys, attended by herdsmen, fed by grain from the Nile Valley. "The camel," he says, "will then, having so to speak burnt its boats, be domesticated in the Nile Valley. And it is interesting to speculate as to how he will develop there. Already the massive Cairo camel is a type distinct from other camels, surpassing all in its cumbrous massive proportions."

THE December number of the *Kew Bulletin* contains, besides the paper on the disappearance of desert plants in Egypt, interesting sections on the Taj Gardens, Agra; Indian gutta-percha; the Gold Coast botanical station; Ramie machine trials at New Orleans; Lord Bute's "Botanical Tables"; and miscellaneous notes. Reference was made to the "Botanical Tables" in the historical account of Kew, printed in the *Bulletin* in 1891, p. 291. Since that was written the authorities at the Royal Gardens have had an opportunity, through the gracious permission of the Queen, of examining the copy in the Royal Library at Windsor, which formerly belonged to Queen Charlotte, to whom the work was dedicated. On the fly-leaf of the first volume of the Windsor copy is the following note in pencil, written by the Rev. John Glover (appointed Royal Librarian by William IV.):—"Of this work only sixteen copies were printed for presents, at a cost, it is said, of more than £10,000. This copy belonged to Queen Charlotte, and was purchased at the sale of Her Majesty's Library for, I believe, £100." There seem, however, to have been only twelve copies. The general nature of the contents is indicated in the *Bulletin*. There are nine volumes, and the work contains 654 plates, all of them apparently drawn and engraved by John Miller, an excellent German artist—Johann Sebastian Mueller, who thus anglicised his name.

CEYLON is sending to the Chicago Exhibition a complete reproduction of a Buddhist temple and many interesting specimens of ancient Sinhalese art, including, according to the *Ceylon Observer*, "exquisitely-carved pillars, massive doorways and dados, beautiful windows and frescoed panellings of courts." There will also be, among other things, a display of jewellery, lace, and pottery. It is hoped that these treasures will do something to further in America "the interests of the most modern product of Ceylon, tea."

AT the recent meeting of the Congress of Americanists at Huelva, Mrs. Zelia Nuttall, of the Peabody Museum of American Archæology and Ethnology, Cambridge, Massachusetts, presented a preliminary note on the calendar system of the ancient Aztecs. Guided by a statement in a Hispano-Mexican MS. which she has recently discovered in the National Central Library of Florence, Mrs. Nuttall claims to have found the key to the Aztec calendar system. She exhibited tables showing that the Mexican cycle was 13,515 days, and that it comprised 52 ritual years (less five days at the end of the cycle), of 260 days each, or 51 lunar years of 265 days each, based on nine moons, or 37 solar years each of 365 days. At the end of the fifty-first lunar year 10 intercalary days placed the solar years in agreement with the lunar years in such a manner that the new cycle recommenced in the same solar and lunar positions as the 13,515 preceding days. Each period commenced with a day bearing one of the four names: *acatl*, *tecpatl*, *calli*, *tochtli*. The calendar system and tables, 14 metres long, designed to

illustrate this communication, were subsequently placed on exhibition in the Spanish section of the Historical Exhibition at Madrid. Her Majesty the Queen of Spain commanded that Mrs. Zelia Nuttall should be presented to her, and expressed much interest in her work.

No one expects to see the corncrake in Great Britain after the summer months. According to the *Llangollen Advertiser*, a specimen was caught last Thursday in the neighbourhood of Pentrefelin, Llangollen. Several local naturalists have seen the bird, and agree that it is a corncrake.

A NEW luminous fungus has been forwarded to Europe from Tahiti. It is said to emit, at night, a light resembling that of the glowworm, which it retains for a period of twenty-four hours after having been gathered, and it is used, by the native women, in bouquets of flowers for personal adornment in the hair and dress. It belongs to the section "dimidiati" of the genus *Pleurotus*, in which no luminous species has been hitherto known, although there are several in the genus, and has been named by M. Hariot *Pleurotus lux*. It is believed to grow on the trunks of trees.

A THEORETICAL investigation of the conditions under which Lippmann's coloured photographs are produced is given by M. G. Meslin in the *Ann. de Chim. et de Phys.* for November. He maintains that the colours produced are complex, and belong to the higher orders of Newton's scale. This is illustrated by the change in colour observed when the thickness of the film increases. When moist air is blown upon it the film swells, and the bright colours give way to others consisting principally of red and green. The impure nature of the spectrum ordinarily obtained would account for its "metallic" appearance. Besides, there is a blue or greenish-blue region which extends beyond the red end of the spectrum. The composite nature of the colours reflected from the surface of the spectrum photograph may be shown by projecting a similar spectrum upon the film. The colours will then appear very brilliant. But if, for instance, the green is projected upon the red of the film, green is reflected all the same, although less distinctly than before. The same thing happens in other parts of the spectrum. On moving it from the violet towards the red, the violet, arriving at the green portion, is interrupted by a broad band. On further displacement this band, the breadth of which is about equal to the distance between the E and the b lines, moves through the green and yellow and reaches the red. At this moment the blue and violet regions show the greatest brightness. There is only one band observed throughout. This observation is in accordance with the thickness attributed to the layers, viz. between 200 and $350\mu\mu$. Hence the paths traversed by the light will range from $400\mu\mu$ to $700\mu\mu$, giving $\frac{\lambda}{2}$ for none of the colours, $\frac{3}{2}\frac{\lambda}{2} = 600\mu\mu$ for the violet, $650\mu\mu$ for the blue, and $700\mu\mu$ for the green. It will be still greater, *i.e.* $\frac{3}{2}\frac{\lambda}{2}$ for the red, in the infra-red region of the spectrum. There we shall have a black band in the red, while the blue is at its maximum, owing to the retardation being equal to two wave-lengths. Hence the blue region beyond the red corresponds to the infra-red region of the incident spectrum, which in long exposures is able to produce a photographic effect.

DURING the year 1891 about 450 more persons were killed by wild beasts in India than during the preceding year. The number in 1890, however, was abnormally low, and the *Pioneer Mail* calculates that last year's figures were about 250 in excess of the mean. In one district of Bengal—Hazaribagh—no fewer than 205 deaths were due to a single brood of man-eating tigers. The yearly average of persons destroyed by wild beasts in our Eastern dependency is between 2500 and 3000. The mortality from snake-bite is on a much larger scale. Year by year it varies from something over 21,000 to something over 22,000.

AN excellent account of the Experiment Stations established in the United States in the interest of agriculture is given by Mr. R. Warington, F.R.S., in a paper issued by the National Association for the Promotion of Technical and Secondary Education. A fully equipped Experiment Station, he says, is a large and costly piece of machinery, embracing many departments of work. There is one in every State of the Union, and in some States there are more than one; the total number is fifty-four. These Stations are endowed by Congress, £3000 a year being paid to the Station or Stations of each State. If the income derived from the State Legislatures, and from other sources, be included, the average income of each Station is nearly £4000. In nearly every instance the station is connected with the States Agricultural College, and the Station buildings are in its immediate vicinity. The publications of the Stations are made in the form of periodical bulletins and annual reports; for the printing of these a special grant is made by the State, and they are distributed by the Federal Government post free. The issues are very large: 60,000 copies of each Station bulletin are printed in Ohio. Any farmer in the State can at his request receive the bulletins regularly without payment. Mr. Warington expresses a hope that our own County Councils may be encouraged to try to do for agriculture in Great Britain what is so energetically done for it in America by the various States.

A SERIES of investigations on soils is in progress at the Maryland Agricultural Experiment Station, in co-operation with the U.S. Department of Agriculture and the Johns Hopkins University. So far the work has been on the physical structure of the soil and its relation to the circulation of soil water, and the physical effect of fertilizers on soils as related to crop production. The surface tension of various solutions was first of all determined. The solutions chosen included common salt, kainit, superphosphate of lime, soil extract, and ammonia. The soil extract was made by shaking up a little soil with just sufficient water to cover it. The water was afterwards filtered off and used for the determination. This operation reduced the surface-tension of water considerably, but the experiments do not appear sufficiently complete to indicate reasons for this. Analyses of the soils are not given. Ammonia and urine lowered the surface-tension of water considerably below that of the soil extract, and still more below that of pure water. Common salt and kainit increase the surface tension of water, and no doubt this is the reason why the application of these substances to the soil tends to keep it moist, whereas the excessive use of nitrogenous manure has the reverse effect.

THE Chamber of Commerce at Reims has published the statistics of the trade in champagne since 1844. In 1844-45 the value of the trade was 6,635,000 francs, and in the following year it exceeded seven millions. In 1868-69 it amounted to nearly sixteen millions, but fell to nine millions in 1870-71, and then rose in 1871-72 to twenty millions. The value in 1872 73 was twenty-two millions, and it oscillated between this sum and seventeen millions until 1889-90, when it became twenty-three millions. The figures were 25,776,000 in 1890-91; 24,243,996 in 1891-92. The number of bottles used in France rose from 2,225,000 in 1844-45 to 4,558,000 in 1891-92, while the number exported rose during the same period from 4,380,000 to 16,685,900. The year in which most bottles were sent abroad was 1890-91 (nearly twenty-two millions).

MESSRS. SWAN, SONNENSCHEIN AND CO. have issued a translation, by Dr. E. L. Mark, Professor of Anatomy in Harvard University, of the third edition of Dr. Oscar Hertwig's

"Lehrbuch der Entwicklungsgeschichte des Menschen und der Wirbelthiere." The volume is entitled "Text-Book of the Embryology of Man and Mammals." The translator, in his preface, expresses his belief that the work "covers the field of vertebrate embryology in a more complete and satisfactory way than any book hitherto published in English."

The latest instalment of the Proceedings of the Academy of Natural Sciences of Philadelphia contains a valuable paper, by Prof. E. D. Cope, on the Batrachia and Reptilia of North Western Texas. The statements presented in the paper are based on collections made along the eastern border of the Staked Plain of Texas, between Big Spring (on the Texas Pacific R. R.) on the south, and the Salt Fork of the Red River, near Clarendon (on the Denver and Fort Worth R. R.) on the north, a distance of about 250 miles. The collections were made incidentally to geological and palæontological explorations conducted by a party of the Geological Survey of Texas, which was under the direction of Mr. William F. Cummins. While attached to this party Prof. Cope picked up such specimens as came in his way, and a good many others were obtained by Mr. Cummins and by Mr. William L. Black of the party. The total number of species enumerated is thirty-three. The paper may be regarded as supplementary to one published as Bulletin 17 of the U.S. National Museum in 1880, on the Zoological position of Texas.

The following are the lecture arrangements at the Royal Institution before Easter:—Sir Robert Stawell Ball, six lectures (adapted to a juvenile auditory) on astronomy; Prof. Victor Horsley, ten lectures on the brain; the Rev. Canon Ainger, three lectures on Tennyson; Prof. Patrick Geddes, four lectures on the factors of organic evolution; the Rev. Augustus Jessopp, three lectures on the great revival—a study in mediæval history; Prof. C. Hubert H. Parry, four lectures on expression and design in music (with musical illustrations); the Right Hon. Lord Rayleigh, six lectures on sound and vibrations. The Friday evening meetings will begin on January 20, when a discourse will be given by Prof. Dewar on liquid atmospheric air; succeeding discourses will probably be given by Mr. Francis Galton, Mr. Alexander Siemens, Prof. Charles Stewart, Prof. A. H. Church, Mr. Edward Hopkinson, Mr. George Simonds, Sir Herbert Maxwell, Bart., the Right Hon. Lord Rayleigh, and other gentlemen.

The micro-organism which has been shown to be the exciting cause of tetanus or lockjaw is just now especially attracting the attention of bacteriological investigators. Kitasato, who it will be remembered was the first who successfully isolated the bacillus of tetanus, has been continuing his researches on the protective inoculation of animals against this malady. In the current number of the *Zeitschrift für Hygiene* appears an account of some extremely interesting results which he has obtained with mice and guinea-pigs. In his experiments Kitasato introduced subcutaneously into these animals small splinters of wood which had been previously soaked in bouillon-cultures of tetanus, so prepared that only the spores were present. He wished in this way to imitate as nearly as possible the actual manner in which tetanus is communicated, and which in consequence of the sensitiveness of the bacillar form to heat and light and the extremely refractory nature of the spores, is almost invariably due to the accidental introduction of the latter. This theory is also supported by the fact that between the infliction of the wound and the development of symptoms of tetanus there is invariably a distinct lapse of time, during which the spores grow into bacilli and elaborate their toxic products within the system of the animal affected, after which the typical appearances of tetanus arise. The protective material used in these investigations was the serum of a horse artificially rendered immune against tetanus, and in every case out of those mice which had received a small wood-splinter two were put aside and not subsequently inoculated with the protective serum. Kitasato found, as he had expected, that a definite period of time elapsed between the introduction of the splinter and the development of tetanus symptoms; but with hardly an exception, all those mice subsequently treated with the serum recovered, whilst those which had received no protective treatment died exhibiting the typical characteristics of tetanus. Moreover, it was found that the earlier the application of the serum took place after the infection and quite irrespective of the appearance of any signs of tetanus, the more successful was the result and the smaller the dose of serum necessary, whilst when the wood-splinters and the serum were introduced together no symptoms whatever of tetanus declared themselves. The same successful results were obtained in the case of guinea-pigs. In connection with the excessively hardy nature of the spore-form of tetanus, Herviejean (*Ann. de la Soc. méd-chir. de Liége*, 1891) has found that even after eleven years such spores still retain their power for mischief. A small fragment of wood was extracted from the ankle of a child who had died of tetanus, and after being kept for nearly eleven years part of it was introduced under the skin of a rabbit, which afterwards died of tetanus. The infection was further confirmed by the discovery of tetanus bacilli in the pus of the wound.

The chloraurates and bromaurates of cæsium and rubidium have been prepared by Messrs. Wells and Wheeler, and are described in the current number of the *Zeitschrift für Anorganische Chemie.* They are all four beautifully crystalline substances. The crystals, which have been measured by Mr. Penfield, belong to the monoclinic system, and form an isomorphous series of identical habitus. These salts are so comparatively insoluble in water that they are obtained in the form of crystalline precipitates when concentrated solutions of chlorides or bromides of cæsium or rubidium are mixed with strong solutions of chloride or bromide of gold. They are, however, sufficiently soluble to admit of recrystallization from water. The crystals of cæsium chloraurate, $CsAuCl_4$, exhibit an orange-yellow colour; those of the corresponding rubidium salt, $RbAuCl_4$, possess a more deeply orange tint; while the two bromides, $CsAuBr_4$ and $RbAuBr_4$, are jet-black but yield a dark red powder upon pulverization. The cæsium compounds are much less soluble than the rubidium ones, so that the crystals are usually much smaller. The more soluble rubidium salts readily form very large crystals; the chloride in particular yields crystals whose size appears only to be limited by that of the crystallizing vessel and the depth of the solution. The crystals, however, whether large or small, all partake of the same character; they are elongated prisms terminated by the basal plane, orthodome, clinodome, and small pyramidal planes. The faces are usually extremely brilliant, but those of the bromides are often singularly hollow or cavernous. In addition to this well-defined series, another chloraurate of cæsium has been obtained containing water of crystallization. This salt, $2CsAuCl_4.H_2O$, is formed when a large excess of gold chloride is present compared with the amount of cæsium chloride. It separates in the form of light orange-coloured tabular crystals belonging to the rhombic system, which exhibit the peculiar property of undergoing an internal change accompanied by elimination of the water of crystallization, within a few minutes of their removal from the mother liquor. The change is probably due to the passage of this hydrated salt into the relatively more stable anhydrous chloraurate described above. It betrays itself in a most interesting manner under the microscope, in polarized light. When a crystal plate is removed from the mother liquor,

rapidly dried by means of blotting-paper and placed under the microscope, the Nicols being crossed, it simply produces the usual effect of causing the field to become coloured with some homogeneous tint. But after the expiration of three or four minutes the molecular change begins to be rendered apparent at the circumference of the field by a rapid augmentation of the polarizing effect; in another moment it commences to dart across the field in all directions, the brilliantly coloured rays being feathered with offshoots, reminding one of the rays of crystallizing ammonium chloride. This beautiful effect continues until, in less than ten minutes after the removal of the crystal from the mother liquor, the rearrangement of the molecules has become so general that light is no longer able to penetrate, and the crystal becomes completely opaque. Messrs. Wells and Wheeler have also attempted to prepare the analogous compounds containing iodine, but have not yet obtained them in a condition so pure or well crystallized as the salts described above.

THE additions to the Zoological Society's Gardens during the past week include a white-fronted lemur (*Lemur albifrons* ♀) from Madagascar, presented by Mr. M. C. Parker; a brown capuchin (*Cebus fatuellus* ♂) from Brazil, presented by Mr. Earle Tudor Johnson; a large-eared fox (*Otocyon megalotis*) from Mashonoland, South Africa, presented by Mr. B. B. Weil; two black-backed jackals (*Canis mesomelas*) from South Africa, presented by Capt. Ralph H. Carr-Ellison; a common fox (*Canis vulpes* ♀) from Arabia, presented by Miss Morgan; a leadbeater's cockatoo (*Cacatua leadbeateri*) from Australia, presented by Lieut.-Colonel Warton; a Rhesus monkey (*Macacus rhesus*) from India, deposited.

OUR ASTRONOMICAL COLUMN.

COMET HOLMES (NOVEMBER 6).—The following is the ephemeris for Comet Holmes for the ensuing week:—

1892.	R.A. (app.) h. m. s.	Decl. (app.) ° ′	Log *r*.	Log Δ.
Dec. 15 ...	0 49 34 ...	+34 50·1		
16	50 15 ...	45·8 ...	0·4004 ...	0·2813
17 ...	50 57 ...	41·6		
18 ...	51 41 ...	37·5		
19 ...	52 27 ...	33·6		
20 ...	53 14 ...	29·8 ...	0·4027 ...	0·2931
21 ...	54 3 ...	26·1		
22 ...	0 54 53 ...	+34 22·6		

Owing to the extremely bad weather, observations of this comet have not been numerous, but from all accounts not much change has taken place in the general appearance, except that the central nucleus seems to possess two small tails, which extend towards the ragged edge of the exterior portion.

COMET BROOKS (NOVEMBER 20, 1892).—Last week the only ephemeris of this comet at hand was one showing its position every fourth day, but Prof. Kreutz has now communicated to *Astronomische Nachrichten*, No. 3132, a daily ephemeris, from which the following is extracted:—

1892.	R.A. (app.) h. m. s.	Decl. (app.) ° ′	Log *r*.	Log Δ.	Br.
Dec. 15...13	50 10 ...	+31 57·3			
16...	54 6 ...	33 17·2 ...	0·0974 ...	0·0001 ..	3·67
17...13	58 19 ...	34 41·2			
18...14	2 53 ...	36 9·5 ...	0·0946 ...	9·9775 ...	4·13
19...	7 51 ...	37 42·2			
20...	13 17 ...	39 19·3 ...	0·0921 ...	9·9550 ...	4·63
21...	19 13 ...	41 0·8			
22...	25 46 ...	42 46·6 ...	0·0898 ...	9·9332 ...	5·17

From the column showing the brightnesses it will be seen that a considerable increase in this comet is taking place. The comet will be easily found by the fact that it lies in the prolongation of a line joining β and γ Bootis (December 18) at a distance equal to that between those two stars.

THE NEW BROOKS' COMET.—The following positions of this comet are reported from Marseilles, by MM. Esmiol and Fabry:—

Date.	Marseille Mean Time. h. m. s.	App. R.A. h. m. s.	App. P.D. ° ′ ″
Nov. 24 ...	17 45 16 ...	13 3 14·6 ...	74 51 33
24 ...	17 6 53 ...	13 4 39·39 ...	74 33 18·1
29 ...	16 43 46 ...	13 11 1·76 ...	72 11 46·7
30 ...	16 41 49 ...	13 12 45·77 ..	71 34 49·0

The comet presented the appearance of a nebulosity about 1′ in diameter, diffuse at the edges, and brighter towards the centre, but without a well-defined nucleus. Its brightness was about that of a star of eleventh magnitude.

NOVA AURIGÆ.—Nova Aurigæ has again increased in magnitude, observations showing that visibly it is 8·5, while photographically it is three magnitudes fainter.

ASTRONOMY AT COLUMBIA COLLEGE, U.S.A.—The latest number of the bulletin issued by this college informs us that with the consent of the governing body of the New York Hospital and the college trustees, a new but small observatory is about to be erected on the site Bloomingdale. The instrument, which is at present being constructed by Wauschaff, at Berlin, is a zenith telescope, and it is one of a pair which is going to be used for observations to obtain accurate determinations of the variations of terrestrial latitudes. The other instrument, by order of the Italian government, is going to be mounted at the Royal Observatory of Capodimonte. Both instruments will soon be, if not already, in working order; the observers in America are Prof. Rees and Mr. Jacoby, while M. Higola will undertake the Italian observations.

The library of this college has been recently very much increased by the purchase of the fine library of astronomical and physical works belonging to Mr. Struve, former director of the Pulkowa observatory. This addition amounts to no less than 4361 bound and unbound books, together with 3056 pamphlets.

COMPANION TO THE OBSERVATORY FOR 1893.—This annual *Companion* for the coming year is very similar to the one last published. Mr. Denning gives a list of the principal meteor showers deduced from recent observations, while ephemerides for the planets, together with their satellites, are also inserted. Solar observers will find the ephemeris given on page 22 very useful, this table giving the position-angle of the sun's axis, and the heliographic latitudes and longitudes of the centre of his disc. In addition to several other handy tables and ephemerides, the times of minima of variable stars not of the Algol type, variable stars of the Algol type, maxima and minima of variable stars, and finally a table of double stars are also included.

GEOGRAPHICAL NOTES.

MAJOR THYS, who has recently returned from the Congo Free State, reports that the railway from Matadi to Stanley Pool is progressing rapidly. The works are practically completed for only 14 kilometers out of the 400, but this includes the most difficult region, including the greater part of the ascent to the plateau. In a few months it is hoped that 40 kilometers will be completed, and the malarial coast-belt can then be traversed rapidly, obviating a serious risk to the health of travellers to the Upper Congo.

WE are pleased to find that the Manchester Geographical Society has published the concluding part of the seventh volume of its Journal although, as we had occasion to remark on the appearance of the previous part, it is greatly to be regretted that the people of Manchester do not take a greater interest in a Society which is one they have reason to be proud of. It is, we are convinced, solely to this want of local appreciation that the Journal has to be issued so far behind its proper date as to impair the usefulness of its contents. In the current number there is an interesting paper on Japan by Mr. W. M. Steinthal.

MR. G. A. CRAIG has, we understand, resigned the secretaryship of the Liverpool Geographical Society on account of ill-health.

THE *Scottish Geographical Magazine* for this month contains a paper by Captain Lugard, entitled "Characteristics of African

Travel." The Society presented Capt. Lugard with its silver medal and an honorary diploma of Fellowship. A similar award has been made to Mr. Joseph Thomson in recognition of his services to Geography in Africa.

DR. J. TROLL, an Austrian explorer, is at present engaged in a journey through Central Asia. He reached Samarkand in the end of October. Thence he proposes to pass through Russian and Chinese Turkestan and Mongolia, intending to return by Pekin and Shanghai. In the course of his journey he hopes to visit the ruined city of Karakoram, the ancient capital of Jenghiz Khan.

A RAILWAY has recently been opened from Wiborg, in Finland, to the Imatra Falls, thus bringing the finest rapids in Europe within six hours of St. Petersburg. Hitherto the falls have been reached by canal-steamer and coach, the journey occupying not much less than twelve hours.

MR. JOSEPH THOMSON proposes to use the name "Livingstonia" to describe the whole British sphere of influence north of the Zambesi and west of Lake Nyasa. It is little to the credit of British cartographers that the attempts hitherto made to associate Livingstone's name with the continent of which he was the greatest explorer have practically failed.

THE DESTRUCTION OF IMMATURE FISH.

MR. ERNEST W. L. HOLT contributes to the new number of the Marine Biological Association's Journal another very interesting paper on the results of his North Sea Investigations. He has much to say as to the destruction of immature fish in the North Sea, and makes the following observations on proposed remedial measures :—

It will be admitted that the continued destruction of large numbers of valuable fish before they have had a chance of reproducing their species can only result in increased deterioration of the industry, and that some measures must be taken to put a stop to it. unless we are prepared, and able, by artificial propagation to restock the sea as fast as we deplete it. Briefly the various proposals that have been put forward fall under three headings, viz. closure of grounds frequented by small fish, restriction of sale of undersized fish, and enlargement or alteration of mesh. We have seen that some of the smack-owners have adopted the eminently practical method of forbidding their boats to fish where they are likely to catch much small stuff; but the buyers, though as loud as any in their outcry, do not appear inclined to avail themselves of their undoubted power to check the evil. The proposals for legislative action have been so much discussed of late that I need only advert to such as affect the North Sea district.

It is a matter of common knowledge that the bulk of the destruction by deep-sea trawlers takes place on the eastern grounds, to which I have alluded elsewhere; and since these lie wholly or in part outside the three-mile limit, it has been proposed that they shall be closed to trawling by international agreement. Whether such agreement could ever be arrived at is questionable and if it were, it is not likely that the ensuing legislation could be easily enforced. The great extent of the grounds would involve an enormous and costly Marine Police force, of mixed nationality; and even were such a body much more efficient than one has any reason to expect, there might be considerable difficulty in adequately watching grounds which extend in some cases over fifty miles from shore. Indeed, on our own coasts and elsewhere the success with which legislation limited to the territorial area has hitherto been enforced is hardly such as to encourage us to extend the principle to the open sea.

The various standards of size which have been advocated, in proposals for prohibiting the sale or possession of undersized fish, differ according as the subject has been treated with regard to the marketable qualities of the fish, or to its powers of reproduction; and it may be assumed, I suppose, without argument that the latter is the more rational method of treatment. Still it may be as well to recapitulate the sizes proposed at the Fishery Conference at Fishmongers' Hall last February, since they may be taken to represent the most recent trade opinion on the subject.

They are for turbot and brill twelve inches, for soles and lemon sole (*Pleuronectes microcephalus*) ten inches, and for plaice eleven inches. How far they fall short of the biological limits, at least for the North Sea district, can be judged by comparing them with the table of sizes on p. 384 of the Journal; and, indeed, I may remark that the prohibition of the sale of turbot and brill under twelve inches in length is rather a work of supererogation, since the number of smaller fish of these species that come to market, at all events at Grimsby, is utterly insignificant.

The benefit to be expected from any measure of prohibition depends of course on the vitality of the fish, and it is very generally asserted that the bulk of the small fish trawled on these eastern grounds would not survive if returned. My own experience leads me to believe that this view is correct[1] so long as the present system of long hauls is maintained. Hence we must seek for such a limit as will render the grounds most frequented by these small fish unprofitable to the fishermen (since any less limit would only involve an infinitely greater waste than takes place at present), and in doing so it is necessary to glance at the general conditions of this fishery.

Exclusive of less important forms, the species chiefly met with are plaice, turbot, and soles. The plaice, on most grounds, do not exceed a length of fifteen inches, and are mostly less than thirteen inches in length. The turbot are fairly abundant, but, as I have already shown, almost all immature; soles are scarce. It is only the certainty of being able to fill up with small plaice that induces the fishermen to cross to the eastern side, since the soles and turbot would not nearly pay his expenses by themselves. Now I am confident that if the Conference limit of eleven inches for plaice were enforced, there would still be enough saleable fish left to make the grounds worth visiting, whereas if it were raised to fifteen or even fourteen inches the grounds would assuredly be left alone; and although such would be below the biological limit, I believe the practical closing to our huge fleets of such a magnificent nursery for young plaice would be in itself a sufficient protection for the species. Certain rough patches of ground, practically surrounded by areas yielding only small fish, abound with only large fish; these would still be accessible to fishermen, whereas in any scheme of geographical restriction it would hardly be possible to exempt them. Moreover the restriction of size would probably do away with the destruction of small plaice by shrimp or sole-trawls, since the fish are not injured by being caught in these nets, and if unsaleable[2] would probably be returned.

For turbot, brill, and sole I would advocate the adoption of the biological standards. They are all rather hardy forms, and it appears that immature brill and such immature turbot as are found on our own coasts are chiefly caught on certain banks where the intricate nature of the ground renders short hauls a necessity, so that they could be returned to the sea in good condition, as indeed the smaller of them usually are at present by many fishermen. With regard to soles, I do not think that many undersized fish are caught by deep-sea trawlers,[3] and the substitution of a size limit for the present prohibition of the use of a fish-trawl in the Humber would do away with the anomaly of a law which is not enforced. There is a strong feeling amongst inshore fishermen that the bye-law alluded to is unequal in its operation, since it offers no check to the destruction of small fish on off-shore grounds, only accessible to large boats. Hence a regulation as to the size of fish landed is perhaps preferable to one based solely on territorial conditions somewhat imperfectly understood.

An objection which I have heard urged against any scheme for keeping our trawlers off the eastern grounds is that the summer sole trade in the North Sea would thereby be left entirely in the hands of foreigners. I think that this is, perhaps, rather overstating the case, but anyhow I cannot see that it furnishes any excuse for the present enormous destruction of small plaice and turbot, whilst it is at least possible that the abstention of our own fleet from these grounds in the summer would result in a corresponding increase in the number of soles in the localities where that species congregates in the winter months. I have no knowledge of the migrations of soles, but the Great Silver Pit is equidistant from the Humber and the nearest eastern ground, and as it is the nearest point at which similar physical conditions can be attained, it does not seem improbable that the winter supply of soles in the Pit is in part recruited from the east side of the North Sea.

1 Owing to the great mass of fish caught in a single haul, I consider it quite possible to hold this view without throwing any doubt on the value of the results obtained by my friend Dr. Fulton in his experiments on the vitality of trawled fish (Report S. F. B., 1891).

2 The possession, as well as the sale, should be prohibited, to guard agains the possible dangei of small fish being utilized as manure when the fisherman is also a farmer in a small way.

3 The small soles caught on the Dogger and on the Dowsing are really solanettes (*Solea minuta*).

Another objection is that boats of British nationality are not the only ones engaged in the small fish trade, and it is true that during the summer months a number of German, Dutch, and Danish boats are occupied in catching small plaice. But they are all of small tonnage, some of them only open boats; and I understand that from the manner in which the trawl is handled by German and Danish boats no injury is done to the unmarketable fish, whilst the saleable part of the catch appears to be exported chiefly to London. Hence the proposed measures of prohibition would give no advantage to these nations. The German steam trawlers, according to my information, do not molest the small plaice at all. Of the proceedings of the Dutch bombs I have little knowledge, but from the small size of their gear, their share in the destruction cannot be a very large one. Foreign-caught fish, except Norwegian salmon and mackerel and Dutch soles, including only a small percentage of undersized fish, rarely come to the Grimsby market, but on two occasions large consignments of small plaice, comprising, as I compute, some 31,000 fish, were sent from Denmark, and recently a consignment of turbot has arrived from Norway. These last fish were about 300 in number, all undersized, viz. from 9½ to 17 inches, whilst 4 were only from 8 to 9 inches. This is the only instance which has come under my notice of any considerable number of turbot less than 12 inches being present in the market, and, as we have seen, our own fishermen were not concerned in it.

The last and perhaps the most important objection arises from the difficulty in allowing for that variation in the size of fish of the same species on different parts of our own coast to which Mr. Calderwood alluded in the last number of the Journal, p. 208. The impossibility of utilizing a uniform size limit for all districts sufficiently exemplified by the limit of 11 inches for the plaice proposed by the Conference of last February, which was the result of a compromise between the trade representatives of the North Sea and south and west coast districts. While perhaps unnecessarily high for the Plymouth district, we have seen that it is altogether too small for the North Sea. The difficulty of having different limits, of local application, will only be felt at such a central port or market as London, to which fish are brought, whether by rail or sea, from all districts, but with proper organization the obstacle does not seem insuperable. It is conceivable that the law might be evaded by running cutters from boats fishing in one district to the parts of another, where the limit was lower, but it is little likely that the firms which are in a position to undertake them, would lend themselves to such operations. There is not the slightest reason to apprehend a general conspiracy of evasion amongst the fishermen, and the boats which respected the law would form a more efficient police than all the cruisers in the navy, so far as one may judge by the conditions on the Scotch coast, where convictions of trawlers for infringement of the territorial restriction are frequently secured by the evidence of local line fishermen.

I must leave to others, who are acquainted with the local conditions, to decide whether the imposition of a size limit is desirable in other districts, but for the North Sea I have not the slightest hesitation in recommending this method of legislation, in the terms I have proposed above, as cheaper and likely to be infinitely more efficacious than any other that can be devised in maintaining the supply of the more important kinds of flat-fish. I need hardly observe that its application to the halibut, which is chiefly a line fish, could not fail to be beneficial to that species, since there is no question but that fish caught on the hook will usually survive if returned;[1] but I do not think that the limit need be as high as the biological one, owing to the difference in the conditions of the trawl and line fisheries.

I am not prepared to enter at present into the question of mesh legislation, beyond pointing out that it appears to be the only method by which the destruction of immature round fish, notably haddock and whiting, can be checked, since these species are fatally injured by being caught in the trawl, and would not survive if returned. Any great enlargement of the mesh does not appear advisable, since it would afford an opportunity of escape to the mature sole, of which that active species would be extremely likely to avail itself. The remedy seems to lie rather in an alteration of the arrangement of the meshes in the cod-ends, so as to prevent them from closing. On this subject I have been making investigations, but they are not yet sufficiently complete to yield reliable deductions. It is sufficiently evident, as has often been pointed out, that the great breadth of some of the flat-fish render it impossible to deal with the whole question by restrictions of mesh alone.

The last matter with which I have to deal is the destruction of very small fish by shove-net and shrimp "seines." If it were only possible to induce the men to cull out the small fish in the water they would do no harm at all, and practically I suppose that, as matters are, they do not greatly injure any species of known value except the plaice, although the small number of sole, turbot, and brill destroyed may represent, from the relative scarcity of these species, a more considerable injury than one would suppose. When fishing by day the shove-net men usually return the fish to the sea, but by night this is impossible, and the seine men do not seem to make any effort in that direction either by day or night.

It is a difficult question to deal with, since the shrimp appears to be almost a necessity to some people; at the same time the small plaice which are destroyed must represent an infinitely greater value than the shrimps. If hatcheries were established, and young turbot, brill, sole, and plaice were enlarged after they had been reared through the delicate larval and metamorphosing stages, it is reasonable to suppose that they would be conveyed or would find their way to the sandy margins, which seem best adapted to the succeeding stages of their life-history, only to fall into the net of the shrimper.

I should say that to prohibit the use of any sort of shore shrimp nets during night-time would be a beneficial measure, but there is perhaps sufficient reason for abolishing the industry altogether. Those engaged in it might be sufficiently compensated at a moderate expenditure, if indeed it be not contrary to public policy to admit the existence of a vested interest in an occupation which is essentially injurious to industries affecting a much greater section of the community.

[1] Except fish with air-bladders, caught at considerable depths.

THE NEW TELEPHOTOGRAPHIC LENS.

IN a small pamphlet of thirty pages, written and published by Mr. T. R. Dallmeyer, the author brings together the various notices bearing on the subject of his new telephotographic lens that have appeared during the last twelve months. He also gives an account of the "simple" and "compound" telephotographic lens, with general instructions for their use, including tables of their properties, and a table showing the diameters of circles of illumination necessary to cover the various sized plates used at the present day.

The telephotographic lens is, we may say, the latest advance made in the science of optics as applied to photography. By it we are now able to obtain large pictures of animate things situated at long distances with short exposure. In this invention Mr. Dallmeyer has produced a useful, and what may prove a valuable, instrument, and he has opened up quite a new horizon which will not suffer from lack of workers.

Hitherto the principle involved in the apparatus for the production of large images consisted first in obtaining the primary image, and second, in subjecting this image to the process of enlargement. To obtain the former a concave mirror, or more generally double convex lens, has been employed, while the subsequent magnification has been produced by placing a secondary magnifier or second positive lens behind the plane of the primary image.

This method, except in the case of astronomical work, has not been, we may say, popularly used, for the cumbrousness of the apparatus required, and the length of time necessary for exposure have quite prohibited its use for anything but inanimate subjects.

It is well known that the focal length of a lens is measured for practical purposes from the principal plane passing through one of the nodal points nearest the principal focal plane to that plane: in most lens-constructions this nodal point lies within the lens-mount. Now it will be seen that if this nodal point could be thrown in front of the lens, that is, on that side away from the focus, the focal length, if measured from the lens, would be shorter. This is exactly what Mr. Dallmeyer has done. In the simple telephotographic lens the anterior element, which is of large aperture and short focus, is a positive lens, while the posterior is negative, and of a fractional part of the focal length of the former lens. A diagram showing the lenses in position and the path of a ray of light remind one at first sight of the principle of the Galilean telescope, with this difference, that the rays emerging are not *divergent*, but *convergent*. In the construction

under consideration the size of the image thrown on the screen can be varied at will by simply altering the distance between the elements, but the further the lens is from the focussing screen, the more will be the time of exposure.

With such a lens as this Mr. Dallmeyer has taken many excellent pictures, but perhaps the best idea of its properties will be gathered from the facts obtained by photographing—by means of two cameras, one supplied with a "long focus landscape lens," and the other with the "new telephotographic lens"—the flame of an oil lamp placed at a distance of 20 feet. With *equal* extensions of the camera the image of the flame given by the new lens was five times greater than that by the other.

In the *compound* lens the anterior element before referred to is here replaced by a complete portrait lens, while a negative symmetrical combination takes the place of the posterior element. This lens may be said to be more perfect than the *simple* lens, Mr. Dallmeyer having been able to introduce considerable improvement in the construction.

Some excellent work done with this lens has been exhibited by Messrs. F. Mackenzie and Annan at the Camera Club. The pictures represented a building at a distance of 500 yards. The first, taken with an ordinary rapid rectilinear lens with an extension of 14 inches, gave the house as $\frac{3}{4}$ of an inch long. The second—with the compound tele-photo lens, extension 9 inches from the back lens—gave $2\frac{1}{2}$ inches as the size of the house, while the third, with 30 inches' extension, gave the house as $6\frac{1}{8}$ inches. Although these numbers can give one a very good idea of what this new lens can accomplish, yet the direct copies from photographs inserted in the pamphlet under consideration convey a more vivid impression.

There is no doubt that this lens will find some very valuable applications, that of astronomical photography not being the least of them, for every one knows the great advantage a *short* telescope has over a long one if the degree of magnification in both are equal. W.

ARBORESCENT FROST PATTERNS.

WE have received the following letters with regard to arborescent frost patterns, to which Prof. Meldola called attention in last week's NATURE:—

I AM very glad that Prof. Meldola has called attention to the curved figures of frozen mud (of which the specimens on December 4 were unusually fine), because I hope that some one will explain why the sexangular crystallization which is universal in snow, and general in water, is exchanged both on windows and on muddy pavements for curves. Probably I ought to know all about it, but I cannot remember seeing an explanation, and shall be obliged by reference to one, which will probably be of interest to others besides G. J. SYMONS.

62, Camden-square, London, N.W.

THE interesting "fronds" of muddy ice observed by Prof. Meldola (p. 126) are not very uncommon on the pavements in these "Northern Heights." I saw them on the date which he named, and have more than once studied them. I then noticed that the "interstitial" pavement seemed partly cleared of mud, as if the water had drawn this towards the groups of crystals. The mode of formation recalled to my mind certain phenomena in crystal building within rocks, and I suspect the mud has its influence. Indeed, it seems to me very probable that all these "dendritic" growths of crystals are the results of "impeded" or "constrained" crystallization, to some of which I have called attention in noticing a structure in the Charnwood syenite (*Quart. Jour. Geol. Soc.*, 1891, p. 101). On this point Prof. Sollas makes some important remarks in his well-known paper on the Wicklow granites. T. G. BONNEY.

THE beautiful curved forms assumed by the ice on the paving flags last Sunday were very noticeable in this neighbourhood and Hampstead as well as in other parts of London. What I observed were not quite like those described and figured by Prof. Meldola, but resembled rather the scrolls and volutes which are frequently used in decorative art. The finest piece that I saw was in this square, where several of these scrolls radiated from a central point, and spread over several feet of the pavement. A friend, Mr. E. Swain, observed that where one of these scrolls came upon a puddle of clear water the crystals were continued in a straight line. Such forms are not at all unusual in the freezing of muddy water, and at the present moment the puddles in the road opposite my house are filled with rectilinear crystals of ice, which assume a curved form in the mud at their margins. The peculiarity on Sunday was their large size and beauty. Something analogous takes place when gold or silver is reduced from solutions of its salts by more electro-positive metals. Under certain circumstances

the metal will present itself in the form of curved crystals, if the term be allowable. A pretty spray of gold of this character is figured in the report of my lecture "On the crystallization of silver, gold and other metals," in the proceedings of the Royal Institution, vi., 428. If a piece of cuprous oxide be immersed in a solution of nitrate of silver, there shoot from its surface thin threads of silver, which, after proceeding straight forward for a while, suddenly turn at an angle of 120° or 60°, and make perhaps many other deviations: but sometimes these threads, instead of being straight, are curved; and in that case the threads that branch from them are curved likewise. A magnified drawing of such a formation is given herewith. These strange departures from the usual rectilinear course of crystal formation are very curious, and deserve more study than has hitherto been given them. J. H. GLADSTONE.

17, Pembridge-square, December 10.

PROF. MELDOLA'S letter (p. 125) has been interesting to me, as I noted a striking and similar phenomenon here on Thursday, December 8, in the forenoon. The trottoirs of several streets (east, west, north and south) were covered all over with beautiful patterns, somewhat different from Prof. Meldola's illustration, there being innumerable dark, broad, sharply-contoured leaf-like patches, distant several inches from each other, and connected by finely curved and branched tendril-like stalks. Foggy, with a faint north breeze. I should presume the "leaves" were due to sparse drops of sleet fallen during the night.

Freiburg, Badenia, December 10. D. WETTERHAN.

THE graceful arborescent frost patterns described by Prof. Meldola in last week's NATURE were very conspicuous on the foot-bridge by the side of Charing Cross railway bridge, on the same morning, this being a situation still more exposed to the wind which he mentions as the probable cause.

December 12. J. T. RICHARDS.

I OBSERVED the same phenomenon as Prof. Meldola describes in NATURE of December 8, on the same date, December 4, on pavements in Cheltenham, about 10.45 a.m.; after mid-day they had gone. I saw the patterns on pavements running north and south, as well as east and west. They were most exquisite; some like the illustration, others much more minute; but always in a connected design over the whole flag. They had all the appearance of fossil vegetation. I never saw anything of the kind before. J. J. ARMITAGE.

December 13.

MR. A. W. BENNETT and Mr. E. L. Garbett have also sent communications corroborating the phenomenon observed by Prof. Meldola. The former attributes it to "defoliation of the stones as the result of weathering or wear."

THE MAKING OF RIFLES.

At a recent meeting of the Institution of Civil Engineers, Mr. John Rigby, superintendent, Enfield Factory, read an interesting paper on the manufacture of small arms. We reproduce from the abstract printed for the Institution Mr. Rigby's lucid account of the various processes of manufacture of the components of the Lee-Metford Mark I. magazine-rifle, of 0·303 inch bore, the weapon adopted for the British Army—an account which he prefaced with a general description of the Enfield Factory.

The most important part of a rifle was the barrel, which had always engaged the special attention of gun-makers. Up to the time of the Crimean War, it was, for the bulk of British troops, a comparatively rude tube of iron, lap-welded under rolls and tapering externally, with a cylindrical bore of about $\frac{3}{4}$ inch diameter. The barrel of the present day was a steel tube of accurate workmanship, only $\frac{3}{10}$ inch bore, almost perfectly true and straight, rifled to $\frac{1}{2000}$ inch, and so closely inspected that the existence of the most minute grey or seam in the bore, requiring a highly-practised eye to detect it, was sufficient to condemn it. The material used was produced either by the Siemens-Martin or the crucible process of manufacture, and was supplied to Enfield as a solid round bar $1\frac{3}{8}$ inch diameter and $15\frac{1}{2}$ inches long. After severe testing, this bar was passed through a rolling-mill to draw it to its full length: it was then taken to the forge, the swell at the breech-end was stamped to the required shape by a steam-hammer, and afterwards straightened cold. The next step was to submit the bar, without annealing, to the turning and drilling-machines. The latter were horizontal, the drills operating from each end. In the process of drilling, the barrel revolved at nearly 1,000 revolutions a minute against half-round bits held flat down, a capillary tube, of brass, supplying a soap-and-oil emulsion, at a pressure of 80 lb. to the square inch, to wash out the swarth and cool the cutting-edge. The drills advancing from each end continued boring until a small disk about $\frac{1}{100}$ inch diameter broke out, and the two holes met. The tendency of the drills to follow the line of axis of a revolving bar was one of those curious occurrences in practical mechanics which might be accounted for after observation, but which no one would predict. Occasionally, through some defect in the steel, a drill wandered from the axial line; in this case the barrel was taken from the machine and reset sufficiently to bring the hole true again. To test its truth, a ray of light was made to illuminate the flat bottom of the hole while the barrel slowly revolved. It was very rarely that a barrel was rendered waste from bad drilling. Rough-boring followed with a three-edged bit, the blade being about 4 inches long. The rough external turning was effected in self-acting lathes, which gave the required curved taper. Three or four cutters acted simultaneously, each producing a long cutting that attested the quality of the metal of the barrel. The operation of barrel-setting followed. Previous to rough-turning, the barrels were fairly straight internally, but the removal of the metal caused slight inequalities which were tested by the eye of the barrel-setter, and corrected by transverse blows. This constituted skilled labour of a peculiar character, and was performed by young men of good sight, who were specially trained for the purpose. After middle life the eye generally lost some of the quality necessary for this work, and it was rare to find a man excel in it after that period. Many mechanical devices had been contrived to supersede the simple ray of light laid, as if it were a straight edge, along the surface of the bore; but the eye still remained the arbiter of straightness and could be relied on for very accurate results. The construction of the barrel was completed by the important operation of rifling. In British small-arm factories the system was followed of planing out each groove separately with a hooked cutter, and had been brought almost to perfection. In Continental and American factories the grooves were ploughed out by cutters, with several cutting or knife-edges set at an angle and following one another in the manner of a single-cut file or float. Similar machines had been tried at Enfield, but did not give as smooth a cut as the slower-moving, single-tooth machines. A few passes of a lead lap, fed with fine emery, removed any burr that might remain, and completed the polish; a cylindrical lap, spinning rapidly, was then passed through, and gave the final finish to the barrels. The limits of gauging were from 0·303 to 0·305 inch.

Next in importance to the barrel was the mechanism of the breech, for which the material preferred was crucible cast-steel of a mild character, but capable of being hardened in those parts exposed to the pressure of the bolt. The body was forged in two operations under the steam-hammer; it was then drilled and subjected to a long series of operations, in the course of which the end was recessed to receive the screwed end of the barrel, and the corresponding thread in the recess was milled out in a specially-contrived machine, which insured that the thread should always start in the same place relative to the gauged part of the body, a point of great importance. The bolt, also of crucible cast-steel, was forged under the steam-hammer. A special machine, invented at Enfield, was used to finish the bolt after shaping. After machining, the bolts, packed in wood charcoal in iron cases, were heated and hardened by immersion in oil. The temper of the handle was then reduced in a lead bath. The rest of the bolt was tempered straw-colour. The bolt-head was similarly hardened and tempered.

The other components of a complete rifle were mostly shaped by mills built up to the proposed profile, or by copy-milling machines. The process of drifting was used with good results at Enfield. All such slots or perforations as had parallel sides, and were not cylindrical, were so finished. The common practice in drifting was to push the drift, but at Enfield much better work was accomplished by pulling. It was found that used in this way drifts were very valuable for interchangeable work. The sides were cut with successive teeth, each slightly larger than the preceding one, and the whole length of the drift was drawn through. Emery wheels were also largely used at Enfield as a substitute for finish-milling and filing. The wheels ran under hoods connected with a pneumatic exhaust that carried away the heated particles of steel and grit. It was popularly supposed that a machine once adjusted to turn out a component of a certain size and shape was capable of reproducing such in large numbers, all absolutely identical. This was so far from being the case that no die, no drill, and no milling-cutter actually made two consecutive articles the same size. The wear of the cutters or dies proceeded slowly but surely, and it was only possible to produce in large numbers components of dimensions varying between a superior and an inferior limit. In small-arm manufacture a variation of about one two-thousandth of an inch was about the amount tolerated, but it varied according to the size of the piece. A difference of diameter of one two-thousandth of an inch in the sight axis-hole, and in the size of the pin or axis, would cause a serious misfit, whereas a similar difference in the measurement of the magazine, or of the recess in which it lay, would be quite immaterial. The operations of gauging, proving the barrel, and sighting, were successively described, as also the manufacture of the stock, which was of the wood known as Italian walnut, though largely grown in other countries. Among the smaller components, the screws were mentioned as being rapidly produced by the automatic screw-making machines of Pratt and Whitney.

The Component Store received the various finished parts, which numbered 1591, or, including accessories, 1863, and issued them to the foreman of the assembling-shop. Theoretically, the assemblers should have nothing to do but to fit and screw them together, but in practice small adjustments were found necessary. The amount of correction was generally exceedingly small, and was done wherever possible with the aid of emery wheels. The completed arms were submitted to inspection, and then issued in cases of twenty each to the Weedon Government Store or elsewhere.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The General Board of Studies propose that, in view of the increased attention given to palæontology in the Geological Department, a Demonstrator in Palæozoology be appointed, whose stipend shall be paid out of the students' fees.

The Botanic Garden Syndicate report the completion of the fine range of plant-houses, which have for some years been in course of erection at a cost of some £6000. It is noteworthy that the expense has been kept within the estimate.

The Senate has determined to raise the fee for the Doctor's degree (including M.D. and Sc.D.) from £20 to £25. It has rejected the proposal to increase the annual dues of undergraduates from 17*s.* to £2, and of graduates from 17*s.* to £1, which was put forth in view of the financial needs of the University, by the Fees Syndicate. The proposal to accept life-

compositions for the annual dues was also rejected. Dr. Allbutt Regius Professor of Physic, has been appointed an Elector to the Chair of Botany, in the place of the late Dr. Hort.

The discussion on the plans for the new Geological Museum (given at length in the *University Reporter* for December 13) was highly interesting, and appears on the whole to have been favourable to the scheme proposed, subject to relatively unimportant modifications. Prof. Newton objected that the arrangement of its contents should be zoological rather than stratigraphical; and the Registrary (Mr. J. W. Clark) took exception to the plan of lighting, which would be better if it were from the top rather than the sides. The geological staff were unanimous that the plan put forward was that which best met their needs. It was agreed that the architectural effect of the museum would be very fine, and worthy of Sedgwick's memory.

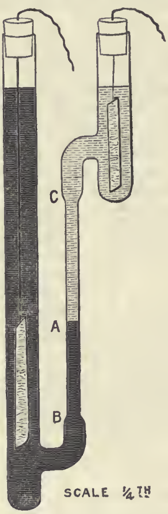
SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 24.—"Ionic Velocities." By W. C. Dampier Whetham, B.A., Fellow of Trinity College, Cambridge. Communicated by J. J. Thomson, F.R.S.

From a series of determinations of the electrolytic conductivity of various salt solutions combined with Hittorf's values for the migration constants, Kohlrausch calculated the velocity of different ions under a potential gradient of one volt per centimetre. Dr. O. Lodge actually observed the velocity of the hydrogen ion as it travelled along a tube filled with sodium chloride dissolved in jelly, decolourizing phenol-phthallein as it went. He found ·0029 cm. per sec., and Kohlrausch gives ·0030.

The author has measured the specific ionic velocity of other ions by observing the motions of a junction between two salt



solutions of slightly different density and different colours, when a current was passed across it. From the velocity of the boundary, that of the ion causing the change in colour can be deduced, The apparatus consisted of two vertical glass tubes about 2 cms. in diameter, joined by a third considerably narrower, which was bent parallel to the others for the greater part of its length. The tube was filled with the solutions in such a manner that the boundary was formed in the vertical part of the junction tube.

When the solutions are of different specific resistances there will be a discontinuity of potential gradient at the boundary and a consequent electrification. The effect on the velocity of the boundary is, however, non-reversible, and, for small differences, can be eliminated by taking the mean of the velocities in opposite directions. The direct estimation of potential gradient is unsatisfactory, but by measuring the current (γ), the area of cross-section of the junction tube (A), the specific resistance of the solution (r), and the velocity of the boundary (v) we can find the specific ionic velocity v, for $v, = \frac{vA}{\gamma r}$.

The first solutions used were those of copper and ammonium chlorides dissolved in aqueous ammonia, the former being blue, the latter colourless. The junction travelled with the current with a velocity of 1·57 cm. per hour going upwards and of 1·60 cm. per hour coming downwards. The mean gives as the specific ionic vel. of Cu in solutions of ·1 gram. equiv. per litre ·000309 cm. per sec. This agrees exactly with Kohlrausch's number for infinitely weak solutions of ·00031 cm. per sec. Other measurements were made for chlorine and for the bichromate group (Cr_2O_7).

The method was extended to alcohol solutions. The velocities of both ions of a salt were determined by using two pairs of solutions. Thus the velocity of chlorine was found by using a cobalt chloride-cobalt nitrate pair, the colours of which are blue and red respectively, and that of cobalt by a cobalt chloride-calcium chloride pair, these being blue and colourless. The sum of these velocities was compared with that deduced by Kohlrausch's method from the conductivity of the solution. The following are the results :—

SPECIFIC IONIC VELOCITIES.

I.—*Aqueous Solutions.*

Ion	Velocity observed	Velocity calculated
Copper	0·00026* 0·000309	0·00031
Chlorine	0·00057* 0·00059*	0·00053
Bichromate group (Cr_2O_7)	0·00048 0·00047 0·00046	0·000473

* Preliminary observations.

II.—*Alcoholic Solutions.*

Salt	Vel. of Anion observed	Vel. of Kation observed	Sum of vels. observed	Sum of vels. calculated
Cobalt Chloride ...	0·000026	0·000022	0·000048	0·000060
Cobalt Nitrate ...	0·000035	0·000044	0·000079	0·000079

December 8.—"On the Velocity of Crookes' Cathode Stream." By Lord Kelvin, P.R.S.

In connection with his splendid discovery of the cathode stream (stream from the cathode in exhausted glass vessels subjected to electric force), Crookes found that when the whole of the stream, or a large part of the whole, is so directed as to fall on 2 or 3 sq. cm. of the containing vessel, this part of the glass becomes rapidly heated up to many degrees, as much as 200° or 300° sometimes, above the temperature of the surroundings.

Let v be the velocity, in centimetres per second, of the cathode stream, and ρ the quantity of matter of all the molecules in 1 c.c. of it. Supposing what Crookes' experiments seem to prove to be not far from the truth, that their impact on the glass is like that of inelastic bodies, and that it spends all their translational energy in heating the glass. The energy thus spent, per square centimetre of surface struck, per second of time, is $\frac{1}{2}\rho v^3$; of which the equivalent in gramme-water-centigrade thermal units is approximately $\frac{1}{2}\rho v^3/42,000,000$. The initial rate at which this will warm the glass, in degrees centigrade per second, is

$$\frac{\frac{1}{2}\rho v^3}{10^6 \times 42\,.\,\sigma a} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1),$$

where σ denotes the specific heat of the glass, and a the thickness of it at the place where the stream strikes it.

The limiting temperature to which this will raise the glass is

$$\frac{1}{E} \times \frac{\frac{1}{2}\rho v^3}{42,000,000} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where E denotes the sum of the emissivities of the two surfaces of the glass in the actual circumstances.

It is probable that ρ differs considerably from the average density of the residual air in the enclosure. Let us take, however, for a conceivably possible example, $\rho = 10^{-8}$, which is what the mean density of the enclosed air would be if the vessel were exhausted to 8×10^{-8} of the ordinary atmospheric density.

To complete the example, take

$$v = 100,000 \text{ cm. per sec.}$$

(being about twice the average velocity of the molecules of ordinary air at ordinary temperature); and take

$$\sigma a = \tfrac{1}{8} \text{ cm.},$$

as it might be for an ordinary glass vacuum bulb; and take

$$E = \tfrac{1}{3000},$$

which may not be very far from the truth.

With these assumptions, we find, by (1) and (2) approximately, 1° per second for the initial rise, and 375° for the final temperature, which are not very unlike the results found in some of Crookes' experiments.

The pressure of the cathode stream of the velocity and density which we have assumed by way of example is ρv^2, or 100 dynes per square centimetre, or about 100 milligrams heaviness per square centimetre, which is ample for Crookes' wonderful mechanical results.

The very moderate velocity of 1 kilom. per second which we have assumed is much too small to show itself by the optical colour test. The fact that this test has been applied, and that no indication of velocity of the luminous molecules has been found, has, therefore, no validity as an objection against Crookes' doctrine of the cathode stream.

Chemical Society, November 17.—Sir Henry Roscoe, Vice-President, in the Chair.—The Chairman congratulated the Fellows on the great improvement effected in the Society's rooms by the alterations carried out during the recess An address has been forwarded to the sister society in Berlin on the occasion of the celebration of its twenty-fifth anniversary. A resolution was passed at a meeting of the Council expressing deep regret that, through the death of Dr. Longstaff on September 23 last, the Society has lost its senior Fellow and one of its Founders. The following papers were read:—Fluosulphonic acid, by T. E. Thorpe and W. Kirman. This paper has been already reported in this volume, page 87.—Note on the interaction of iodine and potassium chlorate, by T. E. Thorpe and G. H. Perry. The reaction which occurs when iodine and potassium chlorate are heated together is usually represented by the equation $3KClO_3 + I_2 = KClO_4 + KCl + KIO_3 + ICl + O_2$; the authors find, however, that the main reaction consists in a simple interchange of iodine and chlorine thus—$2KClO_3 + I_2 = 2KIO_3 + Cl_2$.—The magnetic rotation of sulphuric and nitric acids, and of their aqueous solutions; also of solutions of sodium sulphate and lithium nitrate, by W. H. Perkin, sen. The author has previously shown that the molecular rotation of sulphuric acid is considerably influenced by the presence of water; the rotation rapidly falls for small dilutions, but diminishes as the amount of water is increased. The results are now extended; in the cases of sulphuric acid and sodium sulphate there is no apparent connection between the values representing the rotation and the extent to which dissociation is supposed to occur down to solutions containing 9 per cent. of acid or 12 per cent. of sodium sulphate. At a temperature of 90° the rotation is increased instead of diminished as indicated by the dissociation hypothesis. The results are not inconsistent with the assumption that the hydrate $(HO)_4SO$ is formed. In the case of nitric acid, the curve connecting rotation and percentage of acid is a straight line down to solutions containing 33 per cent. of HNO_3, and then apparently bends down somewhat; the results are not in agreement with the exigencies of the dissociation hypothesis. A compound of the composition $(HO)_3NO$ may be produced. Lithium nitrate resembles nitric acid in its behaviour. The rotations of strong aqueous solutions of the haloid hydrides change very rapidly with small dilutions, but more slowly with larger dilutions, becoming finally nearly stationary; such behaviour is not in accord with the dissociation hypothesis.—Note on the refractive indices and magnetic rotations of sulphuric acid solutions, by S. U. Pickering. Van der Willingen's results for the refractive indices of sulphuric acid solutions yield curves showing a well-marked "break" at 84·5 per cent. (H_2SO_4; H_2O), another "break" at 57·7 per cent. (H_2SO_4; $4H_2O$), and another at 24–30 per cent. The first two of these are also found on the magnetic rotation curves and all three of them agree with breaks found in the examination of other properties. The molecular volumes of solutions of the same strength as those used by Perkin when plotted out exhibit the same three breaks on the curve.—The hydrate theory of solutions. Some compounds of the alkylamines with water, by S. U. Pickering. The following table gives the compositions of a number of crystalline hydrates of fatty amines which the author has succeeded in isolating and analyzing:—

$EtNH_2,5H_2O$	$EtNH_2,5·5H_2O$
$PrNH_2,5H_2O$	$Bu^{\beta}NH_2,7H_2O$
$Et_2NH,5H_2O$	$Me_2NH,7H_2O$
$Pr_2NH,5H_2O$	$Pr^{\beta}NH_2,8H_2O$
Me_2NH,H_2O	$PrNH_2,8H_2O$
$Et_3N,2H_2O$	$Et_2NH,8H_2O$
$Me_3N,3H_2O$	$Me_3N,11H_2O$

The freezing points of the hydrates ranged from + 5° to − 71°; indications of the existence of other hydrates were also obtained by "breaks" in the curves representing the freezing points of the solutions, and in every instance but one a hydrate of the composition thus indicated in the case of one amine was actually isolated in the crystalline condition in the case of some other amine. In connection with this subject Prof. Thorpe showed a very pretty experiment to illustrate the fact that whilst a mixture of triethylamine (15–50 per cent.) is clear and transparent at ordinary temperatures, the solution becomes turbid on warming, owing to the amine being thrown out of solution; on applying pressure to the warm liquid, however, re-solution occurs.—The atomic weight of boron, by E. Aston and W. Ramsay. The authors have investigated the atomic weight of boron; the atomic weight found from determinations of the water of crystallization of borax is 10·921 ± 0·01. The conversion of anhydrous sodium borate into sodium chloride by distilling it with hydrochloric acid and methyl alcohol and weighing the sodium chloride obtained gives an atomic weight of 10·966 for boron. The authors consider that Abrahall's number (10·825) for this constant is too low, as the boron bromide employed by him might have been contaminated with the compound BBr_3,HBr.—Methoxyamido - 1 : 3 - dimethylbenzene and some of its derivatives, by W. R. Hodgkinson and L. Limpach. An almost theoretical yield of 1 : 2 : 4 - metaxylenol may be obtained by steam distilling a diazotized 5 per cent. solution of the corresponding xylidine sulphate. The product solidifies in a mixture of solid carbonic anhydride and ether. On nitration a theoretical yield of a mononitro-derivative ($NO_2 : OH = 1 : 2$) is obtained. A number of other compounds are described.—An extra meeting of the Society will be held on Tuesday, December 13, at 8 p.m., the anniversary of the death of Stas. A paper by Prof. J. W. Mallet, entitled "Jean Servais Stas, and the measurement of the relative masses of the atoms of the chemical elements" will be read and discussed.

Physical Society, Nov. 25.—Prof. S. P. Thompson, F.R.S., Vice-President, in the chair.—The following communication was made: Experiments in electric and magnetic fields, constant and varying, by Messrs. Rimington and Wythe Smith. In the first set of experiments shown exhausted electrodeless tubes and bulbs were rotated rapidly in a constant electric field between two parallel charged discs. Double fan-shaped images were produced by the tubes, due to the displacement currents which pass to equalize the potentials at the ends of the tubes. These fans were not symmetrical with respect to the lines of electric force, but were displaced in the direction of rotation. In explanation of this phenomenon it was pointed out that as a tube rotated the potential difference between its ends increased until this difference was sufficient to break down the dielectric in the tube. The discharges would therefore pass at the ends of the intervals during which the difference of potential was rising, and consequently the images would be displaced from the symmetrical position in the direction of rotation. The number of discharges produced during one revolution was found to depend on the strength of the electric field, but not on the speed of rotation, and that end of the tube which was approaching the negatively charged plate appeared brightest. These experiments were referred to as examples of the direct conversion of mechanical energy into light. Instead of rotating tubes in a constant electric field, the tubes were next kept stationary, and a varying electric field produced by connecting the plates with an influence machine allowed to spark; under these conditions the tubes and bulbs were seen to glow. Using large suspended plates charged by an induction coil, long tubes were caused to glow brightly even at considerable distances away from the plates. The glow could be apparently wiped out by passing the

hand along the tube. Another series of experiments were performed in varying magnetic fields. With a view to showing Hertzian phenomena to large audiences the authors tried Geissler tubes to replace the spark-gap in resonators, with great success. When large Leyden jar circuits were used the effects were very brilliant. Another form of resonator consisted of a bent wire terminating in two plates, between which an exhausted tube was placed. This tube became luminous when the resonator was placed in the vicinity of a fairly large Hertz oscillator. Other experiments similar to those shown before the society at Cambridge by Prof. J. Thomson, on discharges in exhausted bulbs were then made, the bulbs being placed with a coil of wire of four turns, forming the connection between the outer coatings of two small jars, whilst sparks passed between knobs connected with the inner coatings. The bulbs glowed brightly at each discharge, rings of light being seen near their inner surfaces. On putting a ring tube outside the coil this was also seen to glow. The most brilliant part of the glow always occurred in close proximity to the wire coil. A secondary coil, wound by the side of the above-mentioned primary, could be short-circuited at will; this had the effect of decreasing or extinguishing the luminosity in the bulb or tube. Bright sparks passed between the secondary terminals when held a short distance apart, but the shock experienced by touching the ends was not serious. The above arrangement, with the addition of two Geissler tubes placed in series between the outer coatings of the jars, was used to illustrate the fact that closing the secondary diminishes the impedance of the primary circuit of a transformer. Experiments on condensers made of tin-foil on glass were shown. In one of them, parts of the coatings in the form of letters had been removed, and the spaces became luminous when the condenser was connected with an induction coil. In another experiment a glass plate was moved to and from a condenser, and a musical note could be heard whose pitch increased as the distance between the glass plates diminished. The note was said to be the octave of an open organ pipe, whose length was equal to the distance between the plates. Mr. Swinburne thought some of the effects shown were not Hertzian, but merely cases of ordinary mutual induction. He inquired whether the vacuum tubes would still glow if the Leyden jars were removed from the so-called resonating circuits. He was also of opinion that in the magnetic experiments the surfaces of the bulbs, and not the enclosed gases, took the charges. Mr. Watson asked if the authors had tried screening off the long waves by a wet cloth. If the effects still existed, this would prove that they were Hertzian. Mr. Blakesley wished to know if the images of the rotating tubes were at equal angular distances. Mr. Smith pointed out that these distances were not equal, but corresponded to equal changes of potential. Prof. Ayrton remarked that the only cases where the materials of the bulbs, tubes, &c., did not influence the results were those in which discharges were produced by varying magnetic fields. Mr. E. T. Carter thought an induction coil a more efficient machine for producing the glow in tubes than the alternator, &c., used by Mr. Tesla. Mr. Trotter asked if the authors had observed whether the glow produced by passing a discharge through a wire wound in a long pitch spiral round a tube formed an open or a closed circuit of light. Prof. S. P. Thompson said he first noticed that sparks passed between pieces of metal in the vicinity of an induction coil sparking into a condenser in 1876, when he was showing some experiments on telegraphic apparatus before the society, but unfortunately he did not pursue the subject. Long before Mr. Tesla's investigations Dr. Bottomley had shown that exhausted tubes could be caused to glow, but it was not until Tesla produced such phenomena on a large scale that people recognized how much light could be got in that way. Mr. Rimington, in replying to a question by Prof. Thompson, said the notes heard when the glass plate approached the condenser were of very high pitch. The explanation why in the experiments performed in varying magnetic fields, the bright parts of the luminous discharges were near the wire, appeared to be that the E.M.F. was greatest in these places. Although he had not tried the experiment, suggested by Mr. Swinburne, of taking off the Leyden jar, he felt sure that doing so would stop the glow.

Geological Society, November 23.—W. H. Hudleston, F.R.S., President, in the chair.—The following communications were read:—Outline of the geological features of Arabia Petræa and Palestine, by Prof. Edward Hull, F.R.S. The region may be considered as physically divisible into five sections, viz. (1) The mountainous part of the Sinaitic Peninsula; (2) the table-land of Badiet-el-Tîh and Central Palestine; (3) the Jordan-Arabah valley; (4) the table-land of Edom, Moab, and the volcanic district of Jaulân and Haurân; and (5) the maritime plain bordering the Mediterranean. The most ancient rocks (of Archæan age) are found in the southern portion of the region; they consist of gneissose and schistose masses penetrated by numerous intrusive igneous rocks. They are succeeded by the lower carboniferous beds of the Sinaitic peninsula and Moabite table-land, consisting of bluish limestone with fossils, which have their counterparts chiefly in the carboniferous limestone of Belgium, and of a purple and reddish sandstone (called by the author "the desert sandstone," to distinguish it from the Nubian sandstone of Cretaceous age), lying below the limestone. The Nubian sandstone, separated from the carboniferous by an enormous hiatus in the succession of the formations, is probably of Neocomian or Cenomanian age, and is succeeded by white and grey marls, and limestones with flint, with fossils of Turonian and Senonian ages. The Middle Eocene (Nummulitic limestone) beds appear to follow on those of Cretaceous age without a discordance; but there is a real hiatus, notwithstanding the apparent conformity, as shown by the complete change of fauna. In Philistia a calcareous sandstone in which no fossils have been observed is referred to the Upper Eocene; for the Miocene period was a continental one, when faulting and flexuring was taking place, and the main physical features were developed—*e.g.* the formation of the Jordan-Arabah depression is referable to this period. In Pliocene times a general depression of land took place to about 200-300 feet below the present sea-level, and littoral deposits were formed on the coasts and in the valleys. To this period belong the higher terraces of the Jordan-Arabah valley. The Pliocene deposits consist of shelly gravels. Later terraces were formed at the epoch of the glaciation of the Lebanon mountains, when the rainfall was excessive in Palestine and Arabia. The volcanoes of the Jaulân, Haurân, and Arabian desert are considered to have been in active operation during the Miocene, Pliocene, and Pluvial periods; but the date of their final extinction has not been satisfactorily determined. After the reading of this paper the president remarked on the interest of the geology of an area, which was that of the Bible. Many authors had recorded their observations on this district, one of the latest being the author of this paper. Some years ago Mr. Holland had read a paper before the Society, and he (the speaker) believed that that writer was actually the first to prove the existence of carboniferous fossils in the Sinaitic peninsula. He remarked that *Lepidodendron mosaicum*, described by Salter, was somewhere preserved in the Society's museum, so that the Society had long ago had evidence of carboniferous rocks. Mr. Bauerman's paper, which was a reconnaissance in a comparatively unknown district, created great interest; and when that paper was read doubt was expressed as to whether the fossils then exhibited were carboniferous or triassic. After the researches of Prof. Hull there was no doubt that carboniferous rocks do occur in the region. As regards the granitic rocks (extending far up the Nile valley, in the Sinaitic peninsula, and elsewhere), they were all of much the same character, and, according to Sir William Dawson, occurred at two horizons—the lower rocks being granitoid and gneissic, the upper more or less volcanic, but still pre-carboniferous. He asked the author whether the Poudingues de Jebel Haroûn of Lartet were or were not ancient volcanic rocks. The Nubian sandstone of older writers included many things, but the age of the various sandstones was now satisfactorily determined by the author. Some were carboniferous, others (in the speaker's opinion) cenomanian. The calcareous formations of Judæa were well known from the writings of Lartet, Fraas, and others; but the exact line of demarcation between the Nummulitic limestone and the true Cretaceous had never been determined. It was a curious fact, as stated by Von Zittel, that not one fossil was common to the two deposits, which were nevertheless quite conformable. Miocene beds appeared to be absent, for, as noted by Lartet and confirmed by the author, this was a period of movement, when the great valley and the great fault were initiated. He (the speaker) felt that there were many difficulties connected with the depression which had not yet been cleared up. Lartet, Hitchcock, and others had traced the general direction of the fault; but the author had determined its exact site at more than one point. The most interesting point in this connection was the question of the age of the 700-foot saddle separating the Akabah watershed from the Jordan-Arabah depression. This

saddle, in fact, separates the Jordan-Arabah depression from the Red Sea basin. Was it probable that this saddle was contemporaneous with the longitudinal fracture? Much depended on the determination of this question. Canon Tristram had shown that the fishes of the Jordan waters presented some curious analogies with the fish fauna of those of Africa, and Günther, after studying his specimens, had confirmed this view. He (the speaker) believed that this connection was not over the saddle of the Arabah, but might have been the 285-foot pass of the gorge of Jezreel. If the Pliocene depression, which the author thought was at least 200 feet, was a little greater, it would at least cause an outflow in this direction. As to the date of the basaltic eruptions, he thought the author's explanation was not unreasonable. He remarked that the Jordan-Arabah valley must have been of considerable antiquity, and had many lateral valleys of erosion more or less pointing towards the central hollow of the Dead Sea, whether from the Jordan or the Arabah end. Whither had the material thus eroded gone? It could not have passed over the saddle into the Red Sea, for the drainage had evidently been towards the Dead Sea for ages. He allowed that much was soluble limestone; but that must be precipitated somewhere, and the only conclusion he could come to was the somewhat heretical belief that the bottom of the Dead Sea had been an unsound one. Messrs. Irving, J. B. Lee, Topley, Hinde, and Whitaker also spoke. The author accounted for the change of species between the Cretaceous and Eocene limestones, as determined by Zittel, by supposing that at the close of the Cretaceous period the sea-bed had been elevated into a land-surface—but without flexuring—owing to which the life-forms of the Cretaceous ocean were destroyed, and upon resubmergence new forms entered from the outer ocean; in this way there would be no appreciable discordance of stratification, but complete change of species. As regards the origin of the saddle in the Arabah valley, he believed it was formed during the formation of the valley itself, not subsequently; the valley contracted very much at the saddle.—In reply to Mr. Topley's question, the author stated he had been informed that there was a very distinct terrace of gravel near the lake of Huleh, corresponding in level with that in the Arabah valley. About 1200 feet above the Dead Sea surface the intermediate representatives of this terrace may be found, but doubtless had been to a large extent swept away by floods and rains. In attempting to account for the difference between the faunas of the Red Sea and Mediterranean, it would be clear that once the isthmus of Suez had been converted into land, and the seas dissevered, differentiation would begin and proceed till all the forms unsuited to each had disappeared; difference in the temperature of the waters of the two seas would be the chief cause of differentiation.—The base of the Keuper formation in Devon, by the Rev. A. Irving.—The marls and clays of the Maltese Islands, by John H. Cooke.

OXFORD.

University Junior Scientific Club, November 23.—The above club held its 124th meeting in the Physiological Laboratory, Dr. J. Lorrain Smith, President, in the chair.—Mr. E. M. Hamilton, Keble, brought before the club what proved to be a most interesting subject in his exhibit of "Flexible Sandstone," he pointed out that but little was known of the structure and consistence of this curious rock; it was found in India and was known by the name of Itacolumite. Mr. Hornby, Queen's, mentioned that he had investigated part of the specimen exhibited under the microscope after previous crushing; he held that the flexibility was due, not to mica, as was by some proposed, for in some specimens there was no mica, but rather to rough ball-and-socket joints between the grains; this idea was suggested by the irregular indentations observed in some granules and projections in others.—Prof. Green agreed with Mr. Hornby's theory as extremely probable; he gave an able *résumé* of the subject, and expressed his idea that there are more than one kind of rock roughly known as Itacolumite. He pointed out how the ball-and-socket arrangement might be produced, by the influence of pressure, in the presence of some dissolving agent, of which the power would be increased at any point of pressure, and so allow one granule to bore into another.—Mr. Sworn then gave a somewhat lengthy description of some results he had obtained with his rotatory hypsometer in actual use. When after the lapse of time, this subject was exhausted by Mr. Sworn, the club heard Mr. McDonald, Keble, who read a very able paper on the stereochemistry of nitrogen; the paper contained a review of all the latest work on this subject, and was amplified by models illustrative of the constitution of the various isomeric bodies mentioned.—During the meeting it was announced that Lord Kelvin had consented to deliver the "Robert Boyle" lecture in connection with this club, next summer term, the subject being "Magnetic Waves."

December 2.—Dr. J. Lorrain Smith, President, in the chair.—In the absence of Mr. Gunther, Magdalen, Mr. Hill, New College, gave his exhibit of a caterpillar which was found in Java. It was interesting on account of the curious flattened hairs with which it was provided, and has not yet been classified. After a short discussion the President read a paper on the thyroid gland, in which he described a series of experiments performed by him on cats as being the most suitable animal. He found that although the cats almost invariably died after removal of the thyroid gland, yet some lived a considerable time, and even improved in health and appearance. One cat in particular was even now in good health, although it was operated on in June of the present year. However, in this case a decrease of temperature brought on distressing symptoms such as convulsions. He further showed that though the respiration temperature and amount of the products of metabolism varied, the "quotient" remained constant. The animals thus, after removal of the gland, dying "quantitatively and not qualitatively." After a discussion, in which Dr. Turrell, Messrs. Pembery, Ramsden, Butler, and others took part, Mr. V. H. Veley read a paper on the necessity of water in chemical reactions. The author reviewed the works of Baker and others, illustrating his remarks by experiments. Then passing to his own research he showed that concentrated nitric acid did not react with dry sodium nitrite, and further that dry carbon dioxide and sulphurous oxide were not absorbed by dry calcium oxide. If absorption did take place, the amount was directly proportional to the quantity of water present.

DUBLIN.

Royal Dublin Society, November 16.—Prof. W. Noel Hartley, F.R.S., in the chair.—Prof. T. Johnson described an Irish alga—*Pogotrichum hibernicum*—new to science. He found it growing on *Alaria esculenta*, Grev., at Kilkee, co. Clare, in September, 1891. *P. hibernicum* differs from *P. filiforme*, Rke. in having unilocular and plurilocular sporangia in the same tuft, in having endophytic proliferous hyphæ, and in size. Comparison between *P. hibernicum* and *Litosiphon laminariæ*, Harv., of which herbarium material had been examined, was made. The paper was well illustrated by means of the Society's electric projector.—Mr. Alfred Harker then read a paper (communicated by Prof. W. J. Sollas, F.R.S.), on the use of the protractor in field-geology. Representing the inclination of a plane to a fixed plane as a vector of the type given by the gnomonic projection, the author deduces the laws of composition and resolution of such vectors, &c. Since the quantities can be laid down at once by a straight protractor, the common problems of field-geology and mining admit of ready graphical solutions.—Mr. John R. Wigham described a means of preventing the pollution of water of cities and other places where ball hydrants are used. He described the action of ball hydrants which, while making a perfectly tight and true joint while the pressure of water was in the mains, immediately fell from their seats when that pressure was removed for repairs, attachment of service pipes, &c., or reduced for any reason, and thus immediately admitted into the mains any liquid, whether pure or impure, which might be lying on the surface of the street or roads near the hydrant, and pointed out a simple remedy devised by Mr. Kelly, water inspector of Blackrock township. It consists of a spiral spring inserted beneath the ball of the hydrant, which assists the water to keep the ball in its place, and is at the same time strong enough to hold the ball firmly there when the pressure of water is removed. By the adoption of this spring, which is easily applied and inexpensive, costing only a few shillings, all danger of pollution from surface water is absolutely averted.—Mr. G. H. Carpenter submitted a supplementary report on the Pycnogonida collected by Prof. Haddon in Torres Straits, enumerating two additional species—*Pallenopsis Hoekii* (Miers), and *Rhopalorhynchus clavipes*, sp. nov.—Sir Charles A. Cameron, M.D., communicated a paper on the action of phosphine on selenium di-oxide.

PARIS.

Academy of Sciences, December 5.—M. d'Abbadie in the chair.—On an opinion brought forward at the British Association concerning sun-spots, by M. H. Faye. Regarding the suggestion that an electric discharge, in accelerating evapo-

ration, might produce a lowering of temperature sufficient to cause the local decrease of brilliance known as a sun-spot, M. Faye points out the improbability of an electric discharge in a mobile medium lasting for a whole month, with the vapours constantly condensing on every portion of the sun's surface.—Chemical study of opium smoke, by M. Henri Moissan. Samples of the preparation of opium for smoking purposes, known as chandoo, were subjected to fractional distillation between the temperatures of 250° and 400°. At the former temperature a bluish smoke was given off, carrying with it certain agreeable perfumes and a small quantity of morphine. This ceased after a while, and the temperature had to be raised to 300°, when a more whitish smoke was liberated, which was less odorous and more acrid, and contained a small quantity of morphine, together with more or less poisonous bases. The latter reaction was also the only one obtained from the combustion of "dross" and adulterated opium, which give off poisonous compounds, such as pyrrol, acetone and hydropyridic bases.—Observations on the preceding communication, by M. Arm. Gautier.—On stereochemical notation, by M. C. Friedel (reply to the second note by M. Colson).—Calculation of continuous beams; a method in accordance with the new regulations of the ministerial order of August 29, 1891, by M. Bertrand de Fontviolant. This is a method of graphic statics applicable to all cases of moving loads, based upon the construction of the "lines of influences" of the bending moments, shearing stresses, reactions of supports, and elastic yieldings respectively. The problem is the following: Given two points in a plane, A and B, and a system of parallel continuous forces whose intensities are linear functions of the abscissæ of their points of application, to trace a funicular curve of these forces with polar distance equal to $\frac{1}{6}$ the projection of A B on a direction perpendicular to these forces.—Observations of Wolf's periodic comet, made with the great telescope of the Toulouse Observatory, by MM. E. Cosserat and F. Rossard.—Observations of Holmes's new comet, made at the Algiers Observatory, by MM. Rambaud and Sy.—Observations of Brooks's comet (discovered November 21, 1892), made at the Marseille Observatory, by M. Esmiol.—Observations of the same, made by M. Fabry (see Astronomical Column).—On infinite groups of transformations, by M. A. Tresse.—On an indeterminate problem of analysis connected with the study of hyperfuchsian functions resulting from hypergeometrical series with two variables, by M. Levavasseur.—On the fusion of carbonate of lime, by M. H. Le Chatelier.—Remark on a note by M. Barthe concerning the volumetric estimation of the alkaloids, by M. P. C. Plugge.—Physiological researches on opium smoke, by MM. N. Gréhant and Ern. Martin. Experiments performed upon a dog under conditions analogous to those observed by opium-smokers failed to produce any perceptible effect. One of the experimenters then smoked twenty pipes himself, the quantity of opium amounting to four grains. The experiment lasted for an hour. After the fourth pipe a frontal headache supervened, which became general after the sixth. At the tenth he felt giddiness, especially in walking; but these effects were not aggravated up to the close of the experiment, and had disappeared an hour afterwards. The respiration showed a lesser amplitude towards the end, the beating of the heart was slightly less frequent, and the curves of pulsation were more flattened at the summits.—On the measure of the permeability of soils and the determination of the number and the surface of the particles contained in 1 cc. of soil, by MM. F. Houdaille and L. Semichon.—On the exchanges of carbonic acid and oxygen between plants and the atmosphere, by M. Th. Schlœsing, jun.—The artificial production of rutile, by M. L. Michel. The following is a new process: Heat during several hours in a graphite crucible, at a temperature of about 1200°, an intimate mixture of 1 part titaniferous iron and $2\frac{1}{2}$ parts pyrites. On cooling, a crystalline mass is found, which breaks easily, and exhibits all the physical and chemical characteristics of pyrrhotine. This mass is riddled with small holes, to the walls of which are attached crystals, which possess the composition and the crystallographic and optical properties of rutile. They can be easily separated by means of hydrochloric acid.—On a new ellipsometer, by M. Jannettaz.—On the existence of inversion phenomena in the neighbourhood of Gréoulx (Basses-Alpes), and on the age of these dislocations, by M. W. Kilian.

Berlin.

Physical Society, November 4.—Prof. du Bois Reymond, President, in the chair.—Dr. du Bois described and explained the phenomena he had observed during the passage of polarized light through gratings, and dealt with the polarizing effects of the latter. He also discussed the relation of the phenomena to those described by Guy, as accompanying the deflection of light at metallic edges, and to those observed by Hertz during the polarization of long electric waves by wire gratings. Dr. Gross made a further statement on entropy, criticizing Clausius's proofs and advancing a general theorem from which the principle of entropy can be deduced. His views were opposed by Prof. Planck. Prof. Erdmann exhibited excrescences 3 c.m. in length attached to an aluminum penholder which had lain in contact with mercury; they consisted of hydrate of alumina.

Note.—In the report of the meeting of October 21 (Nature, vol. xlvii. p. 24), column one, last line, for "lime-spectrum" read "line-spectrum," and in last line of column two, for "amalgams" read "alloys."

Meteorological Society, November 8.—Prof. von Bezold, President, in the chair.—Dr. Lachmann spoke on temperature extremes in the United States (North America), based on the recently published results of observations extending over twenty years.

BOOKS, PAMPHLET, and SERIALS RECEIVED.

Books.—Child-Life Almanac, 1893 (Philip).—An Elementary Text-Book of Physiology: J. M'Gregor-Robertson, 2nd edition (Blackie).—Reformed Logic: D. B. McLachlan (Sonnenschein).—The Naturalist on the River Amazons: H. W. Bates; with a Memoir of the Author, by E. Clodd (Murray).—Elements of Agriculture: Dr. W. Fream, 4th edition (Murray).—Our Earth—Night to Twilight: G. Ferguson (Unwin).—Report on the Meteorology of India in 1890: J. Eliot (Calcutta).—Carl Wilhelm Scheele, Nachgelassene Briefe und Aufzeichnungen: A. E. Nordenskiöld (Stockholm, Norstedt).

Pamphlet.—Columbus and his Discovery of America: H. B. Adams and H. Wood (Baltimore).

Serials.—Journal of the Marine Biological Association, new series, vol. ii., No. 4 (Dulau).—Engineering Magazine, December (New York).—Himmel und Erde, December (Berlin, Paetel).—Journal of the Straits Branch of the Royal Asiatic Society, December 1891 (Singapore).—Actes de la Société scientifique du Chili, tome ii, 1ère livraison (Santiago).

CONTENTS.

THURSDAY, DECEMBER 22, 1892.

MR. C. DIXON ON BIRD-MIGRATION.

The Migration of Birds: an Attempt to reduce Avian Season-Flight to Law. By Charles Dixon. (London: Chapman and Hall, 1892.)

AMONG prevalent fallacies there are few more mischievous than that which holds a man to be an authority on a subject because he has written a book about it. If the subject be one concerning which the scientific hold divers opinions, or even hesitate to deliver an opinion at all, so much is to the good of such an author, for he will be able to pose all the more securely in the character of a *savant*—though after all that only signifies a "knowing one." If the author can boast of some two, three, or even half-a-dozen works already published, the fallacy becomes almost insuperable, notwithstanding that in zoological works of a popular nature, it is scarcely too hard to say that those who write the most know the least. Nevertheless it remains the duty of the conscientious reviewer to be instant in season with his protest against this general confounding of author with authority. We have read several of Mr. Charles Dixon's works, but hitherto we have been so fortunate that we have been able to keep *in petto* the judgment we have formed of them. It is not given, however, even to reviewers to struggle against fate, and it has been ordained that we should have to criticize his recent volume, the title of which may be read above. To the first sentence of his preface—"There is no branch of Ornithology more popular than that which treats of the Migration of Birds"—we offer no strong objection, and rejoice that there is one spot of ground, be it never so small, that we may occupy in common; but (woe it is!) that here we must part company, for the very next sentence contains a statement which we would willingly let pass as a harmless exaggeration, were it not intensified by the words which follow—and "after that, the dark"!

Mr. Dixon's acquaintance with the subject he has selected is shown by the beginning of his second paragraph—"Notwithstanding the immense popularity and importance of Migration, strange as it may seem, no work has hitherto been devoted expressly to its discussion." He is therefore not aware of the essays of Schlegel and of Marcel de Serres, which (whatever we may now think of them) were in their time "crowned" by the scientific society that published them, and though he straightway proceeds to name the works of Professor Palmén and Herr Gätke, it is to complain of them that they "have only dwelt upon a portion of the subject." Far be it from us to say that Mr. Dixon has not read their works, but really there is nothing to show that his knowledge of them is more than may be picked up from the extracts which have been translated into English and published in this country, or that he has read them to any purpose—that of Herr Gätke especially, because, when further on (pp. 181–186) he comes to deal with it more particularly, he regards it as if it were a mere record of captures or reputed captures of birds in Heligoland, speaking of it with contempt, and the original and rather peculiar views on migration of its author are passed over in silence, as though they were utterly unknown to him. Mr. Dixon states that he is "equally cognizant of the researches of Weissemann" (*sic*) and others, which, except that Dr. Weismann, we think, would deny his having made any, we do not take upon ourselves to gainsay, though our older writers are utterly ignored, and we have a shrewd suspicion that the anonymous author of the "Discourse on the Emigration of British Birds," published at Salisbury more than one hundred years ago, was, from actual observation, more familiar with the main facts than Mr. Dixon is—all flourishes about "avian fly-lines" and "season-flight" notwithstanding—and therefore would have been more competent than he "to bring our knowledge of Migration within the limits of order or to reduce it to Law."

Now this is exactly what in our opinion Mr. Dixon has not done. What the "Law of Migration," of which we read here and on the title-page, may be it passes us to discover. The phrase is full of sweetness, but its elucidation, if we may say so, fails in light. So also is that about bringing our knowledge "within the limits of order," though that may be here taken to mean a dissertation within the limits of 300 pages or thereabouts containing something on the origin and descent of birds, a good deal about the precession of the equinoxes and the eccentricity of the earth's orbit, but still more about glacial epochs. Concerning the "Law of Migration" it is pointless. Let our author at once speak for himself in what seems to be a sort of summary of his faith, though it is long and not reserved to the end of his volume:—

"We will now conclude by following in detail the migration of some single species, say from its Post-Pliocene glacial initiation to the present day, in order clearly to demonstrate Why the habit [of migration] has been acquired, and How it is practised.

"We will select the Spotted Flycatcher (*Muscicapa grisola*) for the purpose. It is one of our best known summer migrants, and one whose present geographical distribution admirably illustrates the phenomenon of Migration. When the Sub-Polar regions of the northern hemisphere last enjoyed a warm, almost semi-tropical climate—one of the mild periods of the Glacial Epoch—the Spotted Flycatcher inhabited in one unbroken area the Arctic woodlands from the Atlantic to the Pacific. Probably it was a resident species becoming partially nocturnal during the Polar night; food was abundant; its conditions of life were easy, and it multiplied apace, and became a dominant, firmly established species during the thousands of years that it dwelt in this Sub-Polar habitat. So matters continued until the slow precession of the equinoxes, in conjunction with increasing eccentricity of the earth's orbit, began to have a marked influence on the climate, and gradually the fair forests and the verdant plains were devastated by the ever-increasing cold. Age after age the Spotted Flycatcher was driven slowly south; summer after summer grew colder and shorter, the periods of Polar darkness more severe. At last matters became so serious that the birds began to leave their northern haunts in autumn, probably because their food became scarce as the various insects either retreated south or began to hibernate. Further and further southward these annual journeys had to be taken, until the Flycatcher at last found its way during winter into Africa, Persia, Arabia, India, China, and even the Philippines and the Moluccas. Summer after summer the belt of breeding-ground became wider and wider, and vast numbers of individuals became separated from

the rest of the species by the lofty mountain ranges, the deserts, and other physical barriers, which would effectually assist a forest or woodland haunting species. More and more severe became the winters, longer and longer; the glaciers descended lower and lower, exterminating or driving before them all living things. At last the Spotted Flycatcher, or the form which then represented this species, came to be divided into two enormous colonies—an African one and a Chinese one—the individuals of each being completely isolated from each other, summer and winter alike. During the ages that this state of things continued, the Flycatchers became segregated into two species, owing primarily to the absence of any intermarriage; the eastern race became smaller, the tail shorter, and the breast-streaks broader; or the western race became larger, with a longer tail and narrow breast-streaks. It is almost impossible to say which form now most closely resembles the ancestral species; but such are the present differences between the two races known to ornithologists respectively as *Muscicapa grisola* (the Western and British form) and *Muscicapa griseisticta* (the Eastern form). Such was the state of things at the close of this Inter-Glacial Period.

"Then came the gradual immigration north again, as precession and lower eccentricity initiated a milder climate. Age after age the journey in the spring became longer. Certain routes to and fro came to be recognized highways of passage; and so imperceptibly did the northern breeding grounds expand that the birds became regular migrants, looking upon the movement north to higher and cooler latitudes each spring as an undertaking never to be missed. Warmer and warmer became the southern haunts, stimulating and widening migration flight to the cooler temperatures prevailing near the edges of the retreating glaciers, where a suitable breeding climate could only be found.

"Let us confine our attention solely to the birds that bred in the British Islands. In the Præ-Glacial ages this area formed part of Continental Europe; a rich and fertile corner, abounding in insect life, full of haunts the Flycatcher loved. After the banishment of its race and the exile of its ancestors in Africa, the northern journey at first did not extend further than the edges of the glaciers on the Mediterranean coasts of Europe. But as these disappeared, and a warmer climate began to prevail in higher latitudes, the annual summer flight was increased. Every century the northern breeding range had increased, creeping slowly across France; higher and higher with the growing vegetation; nearer and nearer to the haunts of old. During the slow, gradual elevation and submergence that isolated Albion from the rest of Europe during Post-Glacial time, the regular spring journey across the sea became wider and wider; but with the intense and inherited love of home in their tiny breasts, the individuals that were born and bred in this district never failed to return each year. For 60,000 years or more has this species now crossed the sea, returning every season, not only to our islands, but each pair of individuals, as long as they live, come back to the exact locality of their previous nests. This long journey, gradually growing longer and longer during thousands of years, until it is now at least a thousand miles in length, has grown to be a deeply-rooted custom sanctioned by the practice of ages of experience and need, and looked upon now as part of the Flycatcher's very existence!" (pp. 58-62).

This, we think, is Mr. Dixon at his best, and we are anxious that our readers should so see him. He goes on to call it a "thoroughly demonstrable instance," which shows what his idea of a demonstration is. We do not deny that all may have happened as he here prescribes, but who knows that it did? To begin with, we may ask what proof is there of the existence on the earth itself of *Muscicapa grisola* "when the Sub-Polar regions of the northern hemisphere last enjoyed a warm, almost semi-tropical climate"? That its ancestors then lived we do not doubt, but who can tell us what they were like? What is meant by its "becoming partially nocturnal during the Polar night"? If so its eyes must since have undergone a considerable change, and that would hardly be unattended by a corresponding change in other parts of the bird's structure. But still it is a pleasing suggestion that "its conditions were easy" in those millenniums, and we hope Mr. Dixon may be right, though for our own part we cannot help fearing that the struggle for existence must have already begun. Certainly it set in at last, and those terrible glaciers drove the poor bird before them, with the effect—Mr. Dixon, we think, is to blame for not giving us the geographical details (which of course must be known to him) of the process—of dividing the species or the form which represented it, and may be presumed (though this is not mentioned) to have by that time got rid of its owls' eyes, "into two enormous colonies—an African one and a Chinese one." These were so isolated that inter-marriage between the individuals of the two portions was impossible, the remarkable consequence of which was that "the Eastern race became smaller" than the Western—a character distinctive indeed of the human races, the Pygmies excepted, now inhabiting the same lands—but with "the tail shorter"—a contradictory character, since the long tail of a Celestial is the really important part of him. We are also told that "it is almost impossible to say which form now most closely resembles the ancestral species," an unexpected confession of ignorance (the "almost" is good) after so much information, but one to which we see the necessity of bowing. However, what is the upshot of all this? And how is any "law" illustrated by it? Setting aside the vagaries on which we have just commented, it reads to us as being merely an amplification of suggestions that were tentatively and cautiously submitted in these columns more than eighteen years ago (NATURE, vol. x. pp. 416 and 459). The partiality of birds for their old homes was then, and (so far as we know) for the first time, pointed out as one possible factor in establishing migratory habit; and, as another (and equally for the first time), the growing divergence of breeding and feeding areas through climatic causes was briefly and clearly set forth by Mr. Wallace. Notwithstanding Mr. Dixon's assertions, he does not seem to have advanced the question one bit, but he has overwhelmed it in a flow of words with a great deal that is, and apparently always will be, incapable of proof. Here and elsewhere throughout this volume we are brought to face one of that school of biologists, the growth of later years, which may be called the Assertive. In some respects it is a very nice one to join. You have only got to say what first comes into your head, and all goes well. Everybody that differs from you is a fool. To some extent this school resembles that Dogmatic one which a few naturalists here and there still remember, inasmuch as the dissentient from either was regarded with the same contempt. The Dogmatists have had their day, but if we look back upon their doings, we shall see that in most cases they had something to go upon which

was not entirely assertion. They were very fond of facts, and undoubtedly preferred founding their dogmatism upon them—indeed, nothing could be more distasteful than to suppose each dogma had not a sound basis. In most cases the worst of which they can even now be accused is that the facts were often above their comprehension, or were understood in the wrong sense. But these men would have scorned the grounding of their dogmas upon imagination. They were perfectly aware (only it had not then been so neatly put) that "Imagination is the fire of Discovery: the best of servants though the worst of masters." Now the Assertive school, of which in this country Mr. Dixon, if he was not the joint-inventor, may be looked upon as a chief leader, rests nearly all on imagination. It matters little whether there is reason behind their assertions or not, and generally, we regret to say, there is none. Conjectures follow upon conjectures and are put forward for the most part as if they were serious deductions from observation. It is not so many weeks since some words, that seem very applicable here were addressed to a scientific audience:—

"We have had enough of the untrained writer of papers, the jerry-builder of unfounded hypotheses whose ruins cumber our field of work."[1]

Mr. Dixon, with his long string of previous books, may demur to being termed a writer of this kind; but he certainly needs to be taught the meaning of the word "probable" and its derivatives. When he has learned it perhaps he will use it in its fit sense. With him, at present, it is in many cases to be rendered "possible," while in not a few *impossible* would be the true equivalent. Now according to all etymologists, and the harmless drudges known as dictionary-makers, "probable" signifies *something that can be proved.* Any reader of average intellect will be able to calculate how seldom this unhappy word is correctly used by Mr. Dixon. It has long been a custom in certain fevers to affix an ice-cap on the patient's head whereby the burning brow is cooled, and some temporary relief afforded; but of late years, as pretty well all know, there has sprung up a small group of writers to whom ice on the brain, instead of being a soothing remedy, is a direct incentive to acts and dicts bordering upon lunacy. On behalf of the Glacial Epoch, the Post-Pliocene Glacial Epoch, to be very particular, we must protest against its being constantly paraded as the greatest event in the history of the globe, to which in its momentous effects all others must give place. That it produced considerable changes and especially in the geographical distribution of plants and animals none can doubt, but that it is accountable for all that Mr. Dixon lays to its charge is hardly likely, and is most decidedly not "probable," since means of proof are wanting. But Mr. Dixon, with others of the Assertive school, is not consistent in his statements, and is apt to forget on one page what he has written on a preceding one. For instance, we are told (p. 33) that "From the commencement of this Glacial Epoch, the Migration of birds, as we see it at the present time, was probably initiated"; and yet, only a few ines further on, our author declares "that we do not require even the occurrence of one Glacial Epoch to account for the Migration of birds," and (p. 34) that "such a cause amply sufficient in every respect is to be found in the varying places of Earth's [*sic*] orbital eccentricity in combination with the precession of the equinoxes"—this statement being immediately followed by a passage, the application, or even the meaning, of which is not easy to understand:—

"That these majestic phenomena are in any conceivable way connected with the migratory movements of birds seems utterly impossible; but in them the habit has its root; and the simple season-flight of a Cuckoo or a Nightingale to and fro between the shores of Africa and England is inseparably and directly connected with the erratic movement of a planet in its orbit; nay, with the constitution of a universe!"

This note of admiration is our author's own: far be it from us to impair its influence.

Though we have confined our remarks to the earlier part of Mr. Dixon's book, we have already devoted a good deal of space to him. There is, however, another point on which we must say a few words. He has thrown out a direct challenge to NATURE, and we should be sorry not to meet it. That he believes in migration the whole volume shows; but there is yet left in his mind a cranny wherein lurks what we may perhaps call a "pious opinion" in favour of torpidity—as a luxury in which a lazy bird may occasionally indulge, even though that bird may be one possessing powers of flight far beyond the average. He is very severe on an anonymous reviewer in these columns in that the "Theory," we use Mr. Dixon's word, of Torpidity "was subjected by him to the bitterest ridicule and denounced as folly." Thereupon he favours us (pp. 12, 13) with another version (substantially, let us say at once, the same as the original, but with fewer details) of the story told by the Duke of Argyll in these pages (NATURE, vol. xv. pp. 527, 528) to say nothing of some other observations, quite irrelevant, as it seems to us, communicated by his Grace to him. But further than this, he cites as an additional witness in defence of the impeached "Theory," Dr. Elliott Coues, who is said to give it "all the support of his authority as an ornithologist of the highest eminence." Now we have a great respect for that gentleman, but his vast reputation fails to hypnotize us, and such support as he gave has already been the subject of comment in these pages (NATURE, vol. xx. p. 2). He will hardly be comforted to learn that the supposition there made has been amply confirmed of late by Mr. Hartert, who informs us (*Cat. B. Brit. Mus.* vol. xvi. p. 481) that the British Museum contains five specimens of *Chætura pelagica* from Central America, beside the one before noticed from Mexico—proving that its range is much about what might have been expected. Thus all the argument based on Dr. Coues's statement, that this species was "not known to winter anywhere out of the United States, nor is it found anywhere in them at that season," falls to the ground, as we are sure that gentleman will readily admit. We allow that it has been very naughty of naturalists if they did prepare this pitfall for Mr. Dixon; but that is not our business, and we cannot imagine they did it intentionally. It is not unlikely that the Chimney-Swift flew out of shot, or too fast for them to bring it down, but they have at last succeeded in "grassing" their bird, with a result so disastrous to the "Theory." One chance

[1] British Association for the Advancement of Science. Edinburgh, 1892. Address of the President of Section H (NATURE, vol. xlvi. p. 379).

yet remains for our author, for though "unfortunately no direct evidence of torpidity has ever come under" his own observation, the *Dundee Advertiser* of April, 1884, supplies him with another straw at which to grasp—not that the newspaper-writer saw it at all in that light, for he called the bird in question a "wanderer," which term is innocently repeated by Mr. Dixon, apparently unconscious that thereby he gives up his case, and drown he must unless some one throws him a life-belt. Meanwhile that of the "hibernating" bird is as desperate. Deprived by the brutal sceptic of its ancient refuge in the depths of Lapland lakes, or in the crumbling banks of Persian rivers, in the mud walls of Orkney or in Irish dung-heaps, or even in nests of its own building in sea-girt Schleswig-Holstein, the *fin de siècle* Swallow desirous of enjoying torpidity has to betake itself to the security of the Bell Rock Lighthouse, and even there to excite no particular astonishment on the part of the honest men who welcomed it. If they had looked upon it as the spirit of Robert Stevenson, or that Abbot of Aberbrothock whose memory was blessed by mediæval mariners, there would have been some excuse for them, but they simply regarded this Swallow as the proverbial one that doesn't make a summer—it was the 12th of March. They will, we think, learn with surprise from Mr. Dixon that "this bird may probably have spent the winter, dormant, near the lighthouse," while he considers "that we here have the most trustworthy evidence of a positive kind." If this does not indicate hibernation capabilities amongst certain birds, pray to what else can it be attributed?" (p. 16). We leave our readers to answer this question as they please, but we fear their answer will not please him. They may, however, like to know how the incident was recorded in the Migration Committee's schedule by the matter-of-fact observer:—"1884, March 12th. One Swallow (Swift) 4 p.m. [Wind] S.E., strong B[reeze] [Weather] cloudy. Arrived much exhausted." No more and no less.

Returning to the position whence we started we must express our deliberate conclusion that Mr. Dixon, author of so many works as he may be, is no authority on the subject of Migration, which he has left exactly as he found it. In the hope he entertains that his volume may form "a basis for more elaborate study and detailed research" we entirely concur. On one, and that the most wonderful part of the whole business, the faculty whereby birds are enabled to perform their extended flights with such punctuality and general unerringness that the more one knows of the subject the more one is amazed at it, he is silent, for it would seem that there are even bounds to his imagination, and for this we are thankful.

DOMESTIC ELECTRIC LIGHTING.

Domestic Electric Lighting, Treated from the Consumer's Point of View. By E. C. De Segundo, Assoc.M.Inst.C.E. (London: H. Alabaster, Gatehouse, and Co., 1892.)

THE author of this small volume is of opinion that there is at present no literature obtainable to enable the untechnical public to form a judgment as to the suitability of applying electrical energy to meet their various requirements, and he states that at present the extended applications of electricity are largely engrossing attention, but owing to the conflicting views expressed by those ignorant or interested, there is a probability of a feeling of disgust being engendered for all things electrical in the lay mind. No doubt there is a good deal of truth in this statement; on the other hand, those who take any interest in this all-important subject will soon learn enough to be able to discern that which is important and worth knowing. The volume under notice has been written in order to fill this want in electrical literature, and to teach the consumer of electrical energy something of the source of the light and power he is using.

It is admittedly a difficult task to make a technical subject clear to untechnical, though interested, readers, and in this case all the more so, on account of the extreme technicalities of electricity as applied to everyday requirements.

The author begins at the very beginning, and in Chapters I. and II. deals with the lighting of rooms with gas, oil, and electricity, naturally pointing out how very soon the atmosphere is vitiated by the two former illuminants, besides the damage done to paintings, book-bindings, &c. When discussing "How shall I light my house best?" the author treats of the efficiency and cost of the different illuminants, and points out that although the electric light may be the more expensive, yet the cost per lamp per hour may be fairly compared with oil or gas, because these illuminants are seldom turned completely out when a room is temporarily empty, whereas the facility of switching on and off an electric lamp must naturally save the current and effect economy.

Chapter III. consists of a short description of some of the systems on which electric light is produced and supplied. Great diversity of opinion exists as to which is the best system on which electric energy should be supplied for public use. In London two systems are in vogue, viz., The high pressure alternating current in conjunction with transformers, and the low pressure continuous current system. From the consumer's point of view, so long as the high pressure current is not allowed to enter the house, it matters little what are the conditions of distribution, provided a continuous low pressure direct supply or a low pressure alternating current from a transformer station is delivered to him, except, of course, where motors are in use, and then the continuous current is a necessity. For installations in the country, separate generating plant is required, and for small installations, where on the average fifteen lamps of 8 c.p. are in circuit at a time, the author says that the electrical energy can be economically generated by chemical means. The primary battery referred to is a modified form of Bunsen, and the cost of producing the light is stated to be one penny per lamp of 8 c.p. per hour. No doubt such a battery takes the place of engine, dynamo, and accumulators, but it is purely a matter of opinion as to the trouble and skill required to look after these batteries, and, without taking the prime cost into account, a gas or oil engine driving a dynamo and charging accumulators to run these fifteen 8 c.p. lamps should not cost fifteen pence per hour. A case is known where an Otto domestic gas engine is easily driving seven and sometimes eight 8 c.p. lamps, and consuming 24 cubic feet of gas per hour, at a cost of considerably under one penny per lamp, the lamps being run direct off the dynamo.

The progress of private electric lighting is simply astonishing, the gas engine being generally the motor used. Many of these engines are run by the Dowson gas, made on the spot, thus rendering a supply of illuminating gas unnecessary.

The author treats somewhat in detail the cost of electric lighting in a house, but as this largely depends on the type of pendants, brackets, &c., used, the outlay naturally varies considerably. The most serious item in the maintenance of an installation is the breakage of the lamps. The author rejoices that this monopoly of manufacture will soon expire, when competition will place better lamps on the market at half the present cost.

Taken as a whole this little book is interesting and useful. It will certainly help the uninitiated consumer to study intelligently the principles of electric lighting, and render his conception of necessary expenses when installing the light more sensible.

OUR BOOK SHELF.

Grasses of the Pacific Slope, including Alaska and the adjacent Islands. Part I. By Dr. Geo. Vasey, Botanist, U.S. Department of Agriculture. 8vo, 50 plates, with descriptions. (Washington: Government Printing Office, 1892.)

THE botanists of the United States Department of Agriculture are working very energetically, and the importance of the herbarium, library, and its publications is increasing year by year. The present work is part of a series of illustrations of the North American grasses, of which we have already noticed two parts, together making one volume, devoted to descriptions and figures of the characteristic species of the South-Western States. The present part, which will constitute half a volume, is devoted to California and the Western States. Dr. Vasey tells us in his introduction that the grasses which are known to grow on the Pacific slope of the United States, including Alaska, number not far from 200 species, which is nearly twice as many as we get in the British Islands. They are all specifically distinct from the grasses growing east of the Mississippi, and also mostly distinct from the grasses of the plains and of the desert, except in that part of California which partakes of the desert flora. A considerable number of the grasses of the mountainous regions of California, Oregon, and Washington reappear in the mountains of Idaho, Montana, and the interior Rockies. The interior of California is a dry region, verging in the extreme south into the desert country, and is deficient in grasses, especially of those species which form a continuous turf. In the present publication fifty of the most interesting species are described and illustrated.

The descriptions are almost wholly the work of Dr. Vasey's assistant, Prof. L. H. Dewey. The illustrations are excellent, and are the work of various artists—F. Muller, W. R. Scholl, T. Holm, and others, and are accompanied by full dissections. The species range under the genera as follows:—Imperata, 1; Panicum, 1; Cenchrus, 1; Phalaris, 2; Hierochloe, 1; Aristida, 1; Spipa, 9; Oryzopsis, 2; Muhlenbergia, 5; Alopecurus, 7; Agrostis, 6; Calamagrostis, 10; Deschampsia, 1; Trisetum, 3; Orcuttia, 2. Only two out of the fifty species are British, *Alopecurus geniculatus* and *Deschampsia cæspitosa*.

J. G. B.

Aids to Experimental Science. By Andrew Gray. (Auckland: Upton and Co., 1892.)

THE chief interest of this little book lies in the fact that it gives a glimpse of the science teaching in one of our colonies. It is a compilation of simple experiments in mechanics, physics, chemistry, physiology and health, and agriculture, to prepare students for what is known as the Class D examination. Naturally, most of the experiments are old ones, but here and there one may gather a new idea. The portion dealing with physiology and health has nothing to do with dissection, but consists of experiments on ventilation, drainage, food stuffs, and the like. An interesting piece of apparatus, devised by Prof. Bickerton for showing the action of the lungs, is described on p. 76. All the experiments are briefly but sufficiently described, and many of them are illustrated.

Science in Arcady. By Grant Allen. (London: Lawrence and Bullen, 1892.)

THIS volume will fully maintain Mr. Grant Allen's reputation as a popular writer on science. The essays of which it consists are written in a bright, lively style, and may be read with pleasure even by original investigators, for the truths with which they deal, if not new, are at least presented from new points of view. Readers who do not profess to know much about any particular branch of science will find in these papers an excellent introduction to some of the more attractive facts and laws of the natural world. The volume includes some archæological essays, which show very effectually that an antiquary has not necessarily much resemblance to Dr. Dryasdust.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Macculloch's Geological Map of Scotland.

IN a recent article in this journal Prof. A. H. Green writes as follows:—

"Macculloch seems to have projected, but never completed, a geological map of the whole of Scotland. The materials collected by him were, however, utilized by the Highland Society in the construction of a general map in 1832."

I am sure that nothing could be farther from the wish of the Oxford Professor than to do an injustice to the memory of one of the greatest of the pioneers in British geology, and he will therefore forgive my calling attention to the following facts, which, judging from a subsequent letter in these pages, would seem not to be generally known.

During the last twenty years of his life Dr. John Macculloch was engaged on a regular survey of Scotland, and in collecting the materials for a geological map of the country. In the earlier part of this period Macculloch seems to have availed himself of the opportunities afforded to him as an official of the Board of Ordnance to carry on his valuable geological explorations. But during the latter part of the period he was regularly employed by Government to complete his geological work, and was paid by the Lords of the Treasury, who in the end published his map.

On July 28, 1834, Macculloch addressed to "His Majesty's Treasury" a series of memoirs respecting the Geological Map of Scotland, which was then completed. In these memoirs he refers to the map as being then in existence, and gives the most minute directions concerning the tints to be employed by the colourists who were to copy the map, in order that it might correspond with his original work. He also expressed his regret that the imperfect topography of the map on which his researches had to be recorded prevented the work from being as accurate as he could have wished at certain points.

Owing to delays in issuing the Government publications—not quite without parallel in more recent times—Macculloch's "Memoirs on the Geological Map of Scotland" did not appear till the year following his death (1836). The date at which the first copies of the map were issued it would probably be difficult to determine, but as to the completion of the map before July 1834,

and its subsequent issue by "the Hydrographer to the King by order of the Lords of the Treasury" there can be no doubt whatever.

The first Government Geological Survey undertaken in the British Islands was that of Dr. John Macculloch, and the work that he accomplished single-handed was a very remarkable one. Several geological maps of Scotland, differing very widely from that of Dr. John Macculloch, have been issued and withdrawn during the last fifty years; but any one who will compare the first geological map of Scotland with the latest, also "published with Government authority," will be interested to see how far the work of the early pioneer in Scottish geology has been found to be correct in most of its essential features by those who have come after him.

John Macculloch's title to be the author of the first geological map of Scotland is as indisputable as are the similar claims of William Smith and Richard Griffiths with respect to England and Ireland respectively. JOHN W. JUDD.

16, Cumberland Road, Kew, December 6.

Glaciers of Val d'Herens.

THE two glaciers of Arolla are interesting, inasmuch as one, the Arolla, is retreating, while the other, Glacier de Zigiorenove, is advancing. This has been going on for twelve years, according to the report which appeared in NATURE (vol. xlvi. p. 386), by Dr. Forel, dealing with Alpine glaciers and their changes.

Having visited these glaciers last summer with the object of observing the effect of their respective movements upon the morainic accumulations in front, I think a brief account may be worth recording.

The Arolla glacier occupies the head of the valley, and is fed by the snow from Mont Colon and the fields of nevé extending towards Mont Brulè. The Zigiorenove glacier is one mile further down the valley, but does not descend so low as the Arolla glacier by about 300 feet. It receives its main supply from the Pigne d'Arolla, a mountain which rises immediately above the glacier, and is conspicuous by its massive snow-cap. This glacier is not only nearer to its supply, but descends at a steeper gradient than the Arolla glacier.

This may in some measure account for the former advancing while the latter is retreating, or, more correctly speaking, melting backwards. I was informed by local guides that the Arolla glacier has been swelling behind for some years; if this be correct, and the seasons remain normal, then, in a short time, this glacier must advance also; in other words, being longer or further away from its feeding ground, the extra supply has not yet had time to reach its extremity. Appearances at the end of the glaciers are in themselves quite sufficient to indicate their respective movements; the snout of the Arolla glacier is buried in its own debris, composed of rocks and loam borne upon or concentrated to the surface as the ice melts. This debris is being constantly shot down grooves or water-courses furrowed in the sloping end or side of the glacier. At the bottom of these spout-like grooves conical-shaped mounts are formed, one behind another, as the ice melts backwards, resulting in a moundy, zigzag arrangement constantly seen lower down the valley, many miles away from existing glaciers, and can be seen also in many of the higher valleys of North Wales.

The advancing Zigiorenove glacier, instead of being buried in debris, turns up in shell-like flanges, exposing its under surface in its endeavour to climb over, rather than push forward, the loose rocks in front; a part of this loose material only is pushed forward, forming a small bank, which in no place exceeded 5 feet in height, up which the ice mounts with the shell-like flanges projecting beyond; the under part of these projections being fluted into a perfectly symmetrical pattern.

In some way the projecting rocks forming the glacier bed produced these convolutions, but whether by cutting, melting, or by the ice crystals flowing round each side, I was unable to determine, but I may state there was no appearance of cutting or grinding which would necessarily leave behind the shavings or ice particles cut out or ground off, and little or no water was present as if from melting. We had much snow for three days, with a total absence of sunshine; the atmosphere at mid-day, when making these observations, registered 38° F. Appearances rather suggested the idea that the ice crystals were displaced in a similar manner to water in a rapid river when it meets with obstructing boulders in its bed.

Climbing up one of the old lateral moraines, for there are several, the glacier is seen to be encroaching laterally as well as longitudinally; it soon extends to the base of the inner moraine, and then climbs upwards in a similar manner as it advances in front by turning up its edges, carrying upwards a few loose rocks in front, but without materially disturbing the moraine itself. Higher up it reaches the top of this moraine, and then rises above it like a wall, having caused the loose rocks it had borne up to roll down into the valley between the inner and outer moraine, with masses of ice broken off the edge of the glacier.

As far as I am able to ascertain, by creeping under the flanges the glacier slowly spreads out the bank which it had pushed up in front as it advances into a more even bed to travel over, but my observations were restricted to a few yards owing to the contraction of the sub-glacial space between the ice roof and the floor. I was much impressed by the fact that the glacier did little in exerting that force which might be expected from such a power behind, in the way of ploughing through or removing such comparatively trifling obstructions as loose rocks or moraine banks.

It is evident from the various ages of moraines that the lower parts of those glaciers have fluctuated considerably during recent times, but the line of demarcation between these minor fluctuations and the period after these lateral valley glaciers had been confluent with the main Valais glacier, and were retreating backwards, is very marked. Beyond two miles down the valley from the Zigiorenove glacier no striæ from the trunk glacier could be found, but at this distance it suddenly appears with fresh glaciated forms; precisely the same phenomenon was noticed in the neighbouring Val d'Anniviers, as if this were the limit of the more recent fluctuations.

At the Col de Bertol, 4500 feet above Arolla, or about 11,000 feet above sea level, there are no indications of glaciation, ancient or modern, above the surface of the snow; so it would appear, however much the ice level has varied below, at this dividing ridge it has always remained the same, or, in other words, it has been dispersed by wind or ice movements to lower levels at a rate equal to deposition, when the snow line was low enough to allow the ice to travel down the Val d'Herens, the higher ice streams would simply run down upon its surface, instead of descending as low level glaciers or mountain rivers, as at present.

WILLIAM SHERWOOD.

Eastbourne House, Sutton Coldfield.

Ancient Ice Ages.

MESSRS. BLANFORD, in their letter (NATURE, p. 101) called forth by Dr. Wallace's notice of a palæozoic glacial conglomerate in Victoria, Australia, say:—"It has become an accepted article of faith amongst most European geologists that no ice-age occurred before the last glacial epoch." There is no doubt that the tendency of opinion has been in that direction, notwithstanding the evidences to the contrary brought forward by Dr. Blanford and others. The late Sir Andrew Ramsay was the first, so far back as 1855, to suggest that the Permian conglomerate of Abberley and the Clent hills was an ancient glacial deposit. Although this reading was accepted by so cautious a philosopher and critic as Sir Chas. Lyell ("Principles," 10th ed., vol. i. p. 223), the idea has languished from disfavour. Having devoted a considerable portion of the last twenty years to the study of glacial phenomena, I early this year paid my first visit to the district. The best section I saw is an excavation at Abberley in what may be called boulder-gravels, and, except for its prevailing red colour, the deposit, if dropped down on the coast of Wales, would, in general appearance and arrangement of the materials, be undistinguishable from many of the glacial deposits to be found there. Many of the stones have flattened faces, and in general shape resemble glaciated boulders, but the striæ, so far as I could observe in the limited time at my disposal, were not very pronounced. Since then I have found a deposit of glaciated gravels on the top of the Screes, Cumberland, 1600 feet above the sea, which on comparison with the specimens brought home from Abberley enables me to understand the latter better. The volcanic rocks of the lake district of which these gravels are composed break up into very similar shapes, and are planed and striated in a very similar way to those of Abberley. I also brought home from Abberley two specimens of the "paste" which fills up the interstices of the finer gravel.

On washing and riddling this clayey matter, well waterworn and smooth gravel was separated from it up to about the size of a bean, and on many of these minute pebbles, with the aid of a microscope of low power, beautifully-developed striæ are to be seen, sometimes on more than one face. This latter fact appears to have been unnoticed before. The conclusion I have come to is that Ramsay had reasonable grounds for his belief in this being a Permian glacial deposit, and think that if he had given more details in his otherwise able paper, geologists would probably have followed him more freely.

T. MELLARD READE.

Park Corner, Blundellsands, December 5.

The Earth's Age.

As Dr. A. R. Wallace's "Island Life" may be regarded as one of the best authorities on its subject, it appears desirable that any errors in it should be pointed out, lest any of its numerous readers should be misled.

In Chapter X. (2nd edition, 1892) is an estimate of the earth's age based on the following data:—Land area of globe, 57,000,000 square miles, coast line, 100,000 miles, width of shore deposits, 30 miles, hence area of shore-deposits, 3,000,000 square miles, hence rate of deposition 19 times as fast as that of mean rate of denudation, which latter is taken to be 1 foot in 3000 years.

Thickness of stratified rocks 177,200 feet, hence time required for deposit 28,000,000 years. This last result is taken to be approximately the earth's age.

It appears to me that Dr. Wallace's data warrant no such conclusion, for, in the 28,000,000 years in question, all that would have been deposited would be a thickness of 177,200 feet of rock, over an area of only 3,000,000 square miles, whereas, what has to be accounted for is an area of 57,000,000 square miles (neglecting igneous rocks and sedimentary deposits beneath existing seas) of the same thickness. Therefore, so far from Dr. Wallace's data leading to 28,000,000 years as the earth's age, they actually lead to a result 19 times as great, viz. 532,000,000 years.

Sir A. Geikie's estimate is (NATURE, vol. xlvi., p. 322), 100 to 680 million years. Personally, I think, the method of taking maximum thicknesses of deposits unsatisfactory, for it assumes that every formation was deposited, with its maximum thickness, over the whole land area of the globe. The absurdity of this supposition is obvious. The only defence of it is that it is held to make an ample allowance (of unknown amount) for repeated denudation. It would, perhaps, be better to ascertain the actual thickness of a great series of successive formations, say in the Colorado Cañon and other regions, and from such data to estimate the total *average* thickness. This estimate, of course, would allow nothing for repeated denudation, but would enable one to form an idea of the earth's *minimum* age.

BERNARD HOBSON.

Owens College, Manchester, December 5.

I AM glad that Mr. Hobson has formulated his difficulty as to the measurement of geological time by the comparative rates of denudation and deposition, because it shows that I cannot have explained my views as clearly as I thought I had done; yet on again reading over pp. 217-223 of "Island Life," I can hardly understand how he has missed the essential point of the argument. Fortunately, there is no dispute as to the data, only as to the conclusions to be logically drawn from them.

Mr. Hobson says that I account for a deposit of 177,200 feet (the supposed thickness of all the stratified rocks) over an area of 3,000,000 square miles (the estimated area over which at any one epoch stratified rocks are being deposited) in 28,000,000 years (the deduced estimate of known geological time); and then adds: "Whereas, what has to be accounted for is an area of 57,000,000 square miles *of the same thickness*" (my italics). This seems to me a most amazing misconception; for it means that every single formation and every stratum or member of each formation, was deposited to the same average thickness over the whole land surface of the globe (area 57,000,000 square miles)! And this implies that at every successive period, from the Laurentian to the Pliocene, the conditions of denudation and deposition were totally different from what they are now, since at the present time it is demonstrable that the area of deposition of continental debris is only a fraction of the whole continental area. It implies further, that during each geological period the whole of the existing land area must have been, either at once or in rapid succession, sunk beneath the sea in order to allow of its being all covered with each successive formation—an amount of repeated upheaval and depression which hardly the most extreme convulsionist of the old school would have postulated. I cannot make the matter clearer, and trust that on further consideration Mr. Hobson will admit that his objection is invalid. ALFRED R. WALLACE.

The Colours of the Alkali Metals.

IN NATURE (vol. xlvii. p. 55) is a communication by Mr. G. S. Newth, entitled "Note on the Colours of the Alkali Metals."

I write to call attention to my article on "The Colour and Absorption-Spectra of Thin Metallic Films, and of Incandescent Vapours of the Metals; with some observations on Electrical Vitality," published in the *American Chemical Journal* (vol. xiv. p. 185) and reprinted in the *Chemical News* (vol. lxvi. p. 163), which gives the method employed by Mr. Newth, as well as other methods for obtaining metals in thin films.

In it attention is also called to the fact that the colour of the film of the metal and the colour of the vapour are widely different.

Mr. Newth, however, succeeded in getting a film from sodium on glass, while I did not, and his success was probably due to the use of a higher vacuum than I employed. He also obtained a rubidium film.

In my paper I called attention to the similarity in colour of the film by transmitted light and that of the *incandescent* vapour which is very striking in many cases. In this respect the film of rubidium as obtained by Mr. Newth follows the rule fairly well; but the film which he got from sodium is exceptional, as according to the analogy furnished by other metals it should be yellow. The presence of potassium, however, might cause the green colour which he observed, by the combination of yellow and purple. WM. L. DUDLEY.

Vanderbilt University School of Chemistry,
Nashville, Tenn., December 2.

Osmotic Pressure.

IN an article on osmotic pressure, in NATURE (*ante*, p. 103), Mr. Rodger very truly remarks that "at present the attitude of the prominent upholders of the new theory [of solutions] is one of indifference as to the exact mechanism of osmotic pressure. The numerical agreement between the measurements on solutions and those on gases is regarded as ample justification for considering dissolved substances to be in a pseudo-gaseous condition." Such an indifference is surely to be regretted from any truly scientific point of view, especially as those explanations which have been given of the mechanism of osmotic pressure have been based on the supposition that the dissolved substance is in a *veritable* and not merely *pseudo*-gaseous condition. There are, however, many reasons for supposing that while the dissolved substance may for many purposes be regarded as analogous to a gas, it must in reality be in a very different condition, and that osmotic pressure is not due to the bombardment of the free molecules of the dissolved substance against a diaphragm through which they cannot pass. The impenetrability of the diaphragm to certain molecules can scarcely be attributed to any other cause than that the molecules are too large to pass through the interstices of the former, and it is scarcely conceivable that the molecules of water which do pass through can be much smaller than the molecules of simple salts, which do not pass through; still less that they can be smaller than the single atoms into which these salts are said to be dissociated.

A very simple experiment, which I mentioned some time ago in the *Ber. d. deutsch Chem. Gesell.* (24, 3639), appears to settle definitely against the view that osmotic pressure is due to impenetrability to the dissolved substance. A solution of propyl alcohol and water was put into a porous pot and immersed in a vessel of water; the water passed through the pot to the solution, and this, according to the usual explanation, would show that the pot was impermeable to the propyl alcohol. The same solution was then immersed in a vessel containing propyl alcohol, when the alcohol was found to pass through to the solution, from which we should have to draw the diametrically opposite conclusion that the pot is impermeable to the water. The true conclusion obviously is that the pot is impermeable, neither to the alcohol alone, nor to the water alone, but to the solution of these in each other, and that the molecules composing this solu-

tion must be larger than those of either of the two substances when separate, the solution consisting of compounds or hydrates of the two. I showed, moreover, in the paper above referred to that the hydrate theory of solutions was quite capable of accounting for and explaining the fact that the dissolved substance may for many purposes be regarded as being in a quasi-gaseous condition in weak solutions, and that calculations based on the idea of its being truly gaseous would yield very nearly correct results.

The hydrate theory will also, as I showed, give an explanation of the fact that electrolytes will give abnormally high osmotic pressures, and that the magnitude of these pressures can be calculated from their electric conductivity: and the explanation based on this theory also obviates many of the objections to which the idea of dissociation into ions is open. Moreover, the only critical experiment which, as far as I know, has ever been made to test the validity of the dissociation hypothesis, gives an unequivocal answer against it, and in favour of the hydrate theory. When, for instance, sulphuric acid is dissolved in excess of water, it is represented by the dissociationists as splitting up into its ions, so that the solution will contain more acting units (ions and molecules) than the acid and water together contained before they were mixed: whereas, on the hydrate theory, combination will have occurred, and there will be fewer acting units present. The number of acting units may be ascertained by observing the depression produced by the solution on some other solvent, such as acetic acid (that is, by using the very method which the dissociationists use to prove the supposed dissociation of substances), and when this is done it is found that the sulphuric acid solution contains *fewer*, instead of *more*, units than the acid and water separately.

Even if the above were the only arguments to be urged, it is evident that although the idea of the dissolved substance being gaseous and often dissociated may be a good working hypothesis for the directing of investigation, it can scarcely be accepted as a true theory of the nature of solutions.

SPENCER PICKERING.

On a Supposed Law of Metazoan Development.

IT is difficult not to feel disappointed that Dr. Beard has given only "a preliminary sketch by way of clearing the ground" (NATURE, vol. xlvii. p. 79), in place of "producing the full argument" for a law in the existence of which he has by "observation and reflection" been led to believe. For it is not easy to gather from his sketch how he is able to apply a universal law to so varied a series of events and phenomena such as he mentions, and at the same time to point out "the analogy which obtains between the suggested mode of Metazoan development, and the accepted fact of an alternation of generations in the life histories of all plants above the lowest Thallophytes." For in the higher plants the alternation of generations referred to occurs with constancy as regards period of life history, and varies only slightly within the limits of the same group.

Dr. Beard alludes, I presume, to one form of alternation of generations—that of sexual with asexual generation only, or Metagenesis. This he asserts constitutes a general law in the development of Metazoa.

In a sense this may be true enough. If, for instance, we regard the division of each cell as a new asexual generation, then Metagenesis is a very constant phenomenon amongst Metazoa. In this case the life history of a Metazoon consists of a sequence of thousands of asexually produced generations alternating with one sexually produced generation, which gives apparently a stimulus for another run of asexual generations in which polymorphism and division of labour are exhibited in extraordinary complexity and beautiful harmony.

But this is not at all what Dr. Beard means. The series of instances which Dr. Beard gives, or system of "nursing" as Steenstrup termed it, is at most a series of disconnected phenomena of frequent occurrence, and not a law.

Because most Metazoa possess eyes, it is not therefore a law of Metazoan development that eyes should be developed. Diversity in form, number, and time of appearance of eyes, is sufficient to show that the law cannot exist; so also is it in the cases of nursing to which Dr. Beard alludes, and on which he bases his argument.

It seems to me that no "law" of alternation of generations in Metazoa can be "enunciated" unless there is evidence forthcoming of its constant action at corresponding periods in the life histories of all animals of different groups, and in a closely similar manner in individuals of one and the same group. Also a law of such a nature, if it is to be found to act universally amongst Metazoa, must surely have come into action at a very early period in the evolution of Metazoa.

Metagenesis is of constant if not universal occurrence in the cycle of life of Protozoa. A long series of generations produced asexually is followed by a generation produced sexually, that is, a generation produced by the conjugation of two individuals; this is followed again by another long series of asexually produced generations, and so on. If this is so constant among unicellular organisms of the present day, it is not very unreasonable to suppose it was common among the protozoan ancestors of the Metazoa and of the Plants. If we are to find any form of Metagenesis as a *universal phenomenon* in the Metazoa, it must be to the most protozoon-like stages of development of the Metazoon that we should look.

There is but one strict meaning to the phrase sexual generation, and that is a fusion of two cells. If Metagenesis means anything it means the alternation of a generation resulting from the fusion of two cells, with one or more generations resulting from the division of cells.

This we can perhaps find in the protozoon-like stages of Metazoan development, and in a way analogous to the alternation of generations among plants.

Spermatozoon and ovum fuse and form the fertilized ovum which is the true sexually produced generation. This produces by division a vast number of cells, and if we regard these as a number of generations then Metagenesis is obvious enough. But it is no more metazoic—if I may use such a word—to call the whole animal resulting from the segmentation of the fertilized ovum, the sexually produced generation.

This generation buds off the immature ovum. This is really the "Primitive ovum" of the embryo. I see no reason why this may not be regarded as a distinct asexually produced generation—like the formation of the spore of the plant.

The immature ovum divides into two cells—first Polar body, and more mature ovum. The more mature ovum divides into two cells, namely, second Polar body and mature ovum. It does not materially affect the argument whether we should regard these two processes as two separate consecutive asexually produced generations, or as one asexually produced multicellular generation. If we take the latter view, then the maturation of the ovum is more analogous to the prothallus stage of the life history of plants.

In either case the result is the formation of the mature ovum, comparable to the oosphere of plants.

The mature ovum fuses with the mature spermatozoon, and the sexually produced generation recurs, and the cycle of development is completed.

I cannot help thinking that if Dr. Beard wishes to discover a law of Alternation of Generations applicable to the whole of the Metazoa, he will find a more favourable hunting ground amongst those stages of development at which the several groups of Metazoa approximate, than amongst those stages where they are farthest apart; and also Dr. Beard will find the analogy between the supposed Metazoan law and the accepted law of the vegetable kingdom closer than he could ever hope to find it if he continues his present line of search.

If the above theory of the cycle of Metazoan life can be considered tenable, we see that both in the Higher Plants and in the Metazoa there are constantly alternating "sporophyte" and "gamophyte" generations, and further, we can find evidence, as we should expect to do, of the origin of such a universal phenomenon in the single celled or protozoan life, where the continuance of the species may be secured in both these ways, namely, by the formation of asexually produced spores, and as a consequence of cell fusion, *i.e.* conjugation.

RIC. ASSHETON.

Oxygen for Limelight.

THE employment of oxygen for limelight and other purposes has increased enormously since the commercial introduction of the Brin method, by which the gas is separated from atmospheric air by a now well-known chemical process. The gas so obtained is practically pure, analysis showing that as now supplied by the Brin companies it contains on an average 95 per cent. of oxygen, the remaining five per cent. consisting of inert nitrogen.

The success of this comparatively new industry has been so marked, that, as a natural result, competitors with rival processes have come forward. Some of these met with failure at an early stage of their career, but others are supplying oxygen to the public. This is by no means a state of things to be deplored from the consumer's point of view, if the product from the one source is as good as the other, for benefit generally arises from healthy competition. But when the rival product turns out to be not oxygen, but a half and half mixture of oxygen and air, with a slight excess of the latter, the competition is of a decidedly unhealthy character, and is correspondingly bad for the consumer. I recently obtained a sample of gas from a dealer, which on testing (with a Hempel absorption pipette, charged with metallic copper and ammonia) I found to be a mixture containing only 60·6 of oxygen. I next tested the illuminating value of this highly-diluted oxygen with a limelight jet, and for sake of comparison, placed by its side a precisely similar jet supplied with Brin's oxygen, and, as might have been expected, the light given by the former was little more than one-half as intense as that afforded by the latter. With the good oxygen the lime cylinder was quickly pitted, whilst the other showed no symptom of destruction. It is also to be remarked that the consumption of the diluted gas was, for a given period, about one-third more—striving with both jets to get the best possible light—than that of good oxygen. On the same principle a mountaineer at a high altitude will pass more (rarefied) air through his lungs than he will when he is in the valley breathing that which contains the normal quantity of oxygen.

As this matter is of great importance to many workers, I trust that you may be able to find room in your valued publication for these words of necessary caution.

T. C. HEPWORTH.

45, St. Augustine's Road, Camden Square, N.W., December 6.

THE STAR OF BETHLEHEM.

IN the *Astronomical Journal* of November 26 we find the second of two very interesting articles written by Mr. J. H. Stockwell, bearing on the chronology of certain ancient events. In the introduction the author discusses and sums up some of the more important and historical dates which he has determined by calculations of ancient eclipses. He next refers to the help which may be obtained in the same direction by means of calculations of conjunctions of the planets, and quite appropriately to the present season points out that the appearance of the star of Bethlehem may have been due to the conjunction of the planets Venus and Jupiter, instead of Saturn and Jupiter, as was suggested on incomplete data by Kepler nearly three hundred years ago. We cannot do better than lay this part of Mr. Stockwell's communication before our readers.

"Although the heliocentric conjunctions of the planets occur with a considerable degree of regularity, and are also very easily calculated, the geocentric conjunctions are subject to many inequalities in the periods of their successive occurrences; so that it requires somewhat elaborate computations to determine accurately the character of any geocentric conjunction of two planets which occurred in ancient times. On account of the frequency of planetary conjunctions, and the indefinite manner in which they are usually described, it becomes a matter of very great difficulty to identify any particular conjunction unless it is associated with some other event whose data can be independently determined. A remarkable case of this character is given in the Bible, for Matthew informs us in the days of Herod the King 'there came wise men from the East to Jerusalem saying, "Where is he that is born King of the Jews? for we have seen his star in the East, and are come to worship him."' From the subsequent inquiries and mandates of Herod the King concerning the time when the star appeared, we are led to infer that its appearance took place within two years preceding the death of Herod, and it has been sought to explain the appearance of the star by means of a conjunction of the planets—the Creator employing celestial phenomena to proclaim 'the good tidings of great joy, which shall be to all people.'

"The illustrious Kepler was the first to suggest that the star of the wise men might be explained by means of a conjunction of the planets Jupiter and Saturn, and he even undertook to calculate the times when such conjunctions took place. Much has been said and written on the subject of the 'star of the wise men' during the past few years; but no important contribution to the natural history of the star has been made since the days of Kepler, nearly three hundred years ago. But the supernatural history and functions of such a star have been discussed in a very able and interesting manner by many writers in theological, literary, and semi-scientific periodicals during the past twenty years, and perhaps nothing of interest and importance can now be added to what has already been published on that subject.

"I find, however, that Kepler overlooked one important element of the problem in his calculations, and consequently left the natural history of the problem in an incomplete and unsatisfactory condition. I shall therefore here attempt to complete more fully what Kepler began, and show that the Biblical narrative concerning the 'star in the east' is better satisfied by a conjunction of Venus and Jupiter than by any of the conjunctions computed by Kepler.

"We have already seen that the death of Herod took place early in the year B.C. 4, and if we can now show that there was a very conspicuous conjunction of two bright planets, visible only in the east, within two years preceding that date, the hypothesis that such conjunction was the event referred to in the Biblical narrative will at least be rendered plausible, if not entirely legitimate; and for this purpose I have here undertaken the calculation of all the conjunctions of the planets which took place near that epoch. I shall first enquire whether there was a conjunction of the planets Jupiter and Saturn about that period of time which would satisfy the required conditions. The mean interval between two heliocentric conjunctions of Jupiter and Saturn is 7253·4638 days; and they were in mean conjunction B.C. 6, January 30. Now the time of true heliocentric conjunction may differ from the time of mean heliocentric conjunction by 241 days, on account of the inequalities in their elliptic motions, and by 23 days more by reason of the great inequalities of long period in their mean motions. But the time of geocentric conjunction of Jupiter and Saturn may differ from the time of heliocentric conjunction by 102 days; so that a geocentric conjunction may occur one whole year before or after the time of mean heliocentric conjunction. In the present instance I find that the true heliocentric conjunction took place B.C. 7, September 23, which is 129 days before the mean heliocentric conjunction; and that there were three geocentric conjunctions during the year B.C. 7, which took place as follows:—

"The first conjunction took place June 7, in which Saturn passed $1^\circ 4'$ to the south of Jupiter; the second conjunction took place September 18, in which Saturn passed $1^\circ 2'$ to the south of Jupiter; and the third conjunction occurred on December 15, in which Saturn passed $1^\circ 8'$ to the south of Jupiter.

"In the first conjunction the planets would have an elongation of about 73° to the westward of the sun, and would be seen during four or five hours in the east in the morning. The second conjunction took place near the time of opposition with the sun, and would be visible during the whole night, so that it could not properly be designated as a star in the east any more than a star in the west. In the third conjunction the planets would have an elongation of about 84° to the eastward of the sun, and could therefore appear only as evening stars

in the west. Moreover, Saturn is not an especially bright planet, and consequently no one of these three conjunctions could have been very conspicuous in the heavens. The first conjunction was the only one that was visible in the east, but it occurred nearly three years before the death of Herod; it could hardly be said to satisfy the conditions required by the narrative. No other conjunctions of Jupiter and Saturn could possibly occur till about twenty years later, so that we may conclude with a light degree of probability that the phenomenon alluded to in the Bible was not occasioned by a conjunction of Jupiter and Saturn. Since the planet Mars is a conspicuous object when near its opposition with the sun, it may be well to inquire whether a conjunction of Mars and Jupiter might not occasion the phenomenon referred to. But since Mars is conspicuous only near its opposition with the sun, it is evident that any conjunction when in that direction would appear as a star in the west as much as in the east, and consequently it would not fulfil the required conditions. There was, however, a conjunction of Mars and Jupiter on March 5, B.C. 6; but at that the planet's elongation was only 18° to the eastward of the sun, and consequently could have been visible only in the west. But Mars was then so far from the earth, and so nearly in conjunction with the sun, that the conjunction would be wholly invisible. At the same time Saturn was not very far from Jupiter, and hence it was said there was a triple conjunction of the planets Mars, Jupiter, and Saturn in the spring of B.C. 6.

"It is evident without calculation there could be no conspicuous conjunction of Venus and Mars at any time; because Mars is not a conspicuous planet unless its elongation from the sun be greater than the greatest elongation ever attained by Venus, so that it would be a waste of time and labour to enter into the computations of any such conjunctions.

"It now remains to inquire whether the two brightest planets of the solar system, Venus and Jupiter, might not have been in conjunction within a short time before the death of Herod, and constitute the phenomenon alluded to in the biblical narrative; for it was the beautiful phenomenon presented by these two planets when in conjunction last February that suggested this investigation. Now the conjunctions of Venus with the sun occur with great regularity at intervals of about 584 days, while those of Jupiter at intervals of 399 days. Moreover, it may easily be shown that all geocentric conjunctions of Venus and Jupiter must take place within about 60 days before or after Jupiter's conjunction with the sun. Therefore, by tabulating the times of Jupiter's conjunction with the sun, we have only to investigate the longitude of Venus for a period of 60 days before or after that event in order to determine whether a conjunction of those planets will then take place. Now I find Jupiter was in near conjunction with the sun B.C. 6, March 29, while Venus was in conjunction on the preceding November 5, or 144 days earlier than Jupiter. Venus was therefore past her greatest western elongation, and was moving towards her superior conjunction, and she would overtake Jupiter on May 8, when their mutual elongations from the sun would be 27° 44′ to the west. At that time the heliocentric latitude of Venus and Jupiter were 3° 21′ and 1° 20′ south, while their geocentric latitudes were 1° 40′ and 1° 8′ south respectively. It therefore follows that at the time of their geocentric conjunction Jupiter was only 32′, or about the angular breadth of the moon to the northward of Venus; and as they were then to the westward of the sun, they would be visible only as a star in the east a couple of hours before sunrise. These two brightest planets in the sky would therefore at the time of conjunction, B.C. 6, May 8, be apparently very close together and produce a striking and beautiful appearance. The date also at which it took place being about 50 days less than two years before the death of Herod, harmonizes well with the spirit and other conditions of the narrative; for it is probable that the mandate for the slaughter of the children of two years old and under was issued some months before his decease, and the limit of two years would leave an ample margin for any uncertainty as to the time of the appearance of the star as related by the Magi.

"There were no other conjunctions of Venus and Jupiter until the year B.C. 2, or nearly two years after the death of Herod, when there were two conjunctions, one of which occurred on August 31 and the other on October 4. The first of these was invisible on account of being too near the sun; but the second took place when Venus was nearly at her largest elongation to the westward of the sun.

"If the preceding calculations, and the references based on them, are correct, it follows that Christ was born as early as May in the year B.C. 6; and if He was crucified at the time of the paschal full moon, which occurred on a Friday, it must have taken place on April 3, in the year A.D. 33. And since any given phase of the moon is repeated on the same day of the week, and also within two days of the same time of the year, at intervals of 334 lunations, or 27 years, it follows there was no paschal full moon on a Friday between the years A.D. 6 and A.D. 60, except the one on April 3, A.D. 33; whence it would seem to follow that Christ was thirty-eight years old at the time of His crucifixion and death, and this would vindicate the sagacity of the Jewish doctors, who had recently affirmed that He (Jesus) was not then fifty (forty) years old."

FUJISAN.[1]

ALL who remember the beautiful plates illustrating the volume on "The Great Earthquake of Japan, 1891," which was issued by the same authors a few months ago, will welcome the first instalment of a work which promises to illustrate, in a manner worthy of the subject, the magnificent volcanic phenomena of Japan. The present part contains ten plates, and is devoted to the illustration of the most famous and beautiful of all the Japanese volcanoes—Fujisan. The number of parts that the authors will publish will depend partly, we are told, on the encouragement they receive, and partly on the number of photographs that they have been able to secure during the past summer.

The photographs in the present part, which are all reproduced as permanent collotypes, 11 inches by 8 inches in size, are exquisite examples of what can be accomplished by this method of illustration, and show that Japan is certainly not behind any country in the world so far as the resources of the publisher go. Where all are so excellent, it is difficult to select any particular plate for especial praise, but one of the most remarkable is certainly Plate II., which gives a view over the great cloud-banks as seen from the summit of Fuji. Nothing can be more striking than the manner in which the effect of the great fleecy masses of vapour are reproduced, and here nothing whatever is lost from want of colour. The plate of greatest scientific interest is perhaps the last, which shows the interior of the crater of Fuji—a great pit 600 to 700 feet deep, with perpendicular walls. The sides are built up of rings of variously-coloured rocks, while snow rests in the sheltered hollows. The remaining pictures illustrate the sacred mountain as seen from different points of view, the graceful curves of its outline, the variation in the distribution of snow on its flanks, and the

[1] "The Volcanoes of Japan. Part I. Fujisan." By John Milne, F.R.S., Professor of Mining and Geology, Imperial University of Japan; and W. K. Burton, C.E., Professor of Sanitary Engineering, Imperial University of Japan. Plates by K. Ogawa. (Yokohama, Shanghai, Hongkong, and Singapore: Kelly and Walsh, Limited, 1892.)

character of the foreground, giving rise to great diversity in these eight pictures.

As an example of these beautiful views, Plate IV.—

"Fujisan from above Hakone"—has been reproduced, although necessarily much of the delicacy of the original has been lost in the process by which it has been copied.

"In the foreground, looking like a river, is the Lake o Hakone, at the back of which are hills some 4000 feet high. At the lowest gap in these hills is the Otome pass. In the background, overlooking both lake and mountains, is the upper part of Fuji. This portion of the mountain is particularly conical, with sides sloping at an angle of

30°, its logarithmic sweep being lost behind the intervening mountains. The almost triangular notch in the snow-cap may possibly represent the scarp that is supposed to have been formed by the great earthquake of 1891, causing a strip of ground in unstable equilibrium to slip downwards." The reader should compare this view with that given in Plate IX., which shows the lake, with the reflection of the mountains behind, and the snow-covered Fuji rising in the background. This plate, and the view, Lake Kawaguchi, given on Plate V., are so delicate and faithful in their portrayal of water and atmospheric effects as to defy reproduction.

No attempt has been made by the authors to produce a scientific treatise, the information contained in the text being of a popular character, and the reader is referred to the Transactions of the Seismological Society of Japan for more detailed information on the subjects treated of. It is nevertheless true that the text published with these plates contains, as the authors claim for it, information not readily obtainable from other sources. The introduction gives a sketch of the volcanic phenomena of the Japan and Kurile Islands, in which we are informed that the number of volcanoes still preserving their form, and with distinct craters, is one hundred, distributed as follows:—In the Kuriles 23, in Yezo 28, in Honshiu 36, and in Kiushiu and the Southern Islands 13. Of these no less than 50 emit steam, while 39 are distinguished by their beautiful and graceful outlines. The number of great eruptions of which there is any published record is 233, the greater frequency, as with earthquakes, having been during the colder months of the year. One line of vents, which is more than 2000 miles long, begins in Kamsatka, passes through the Kuriles, Yezo, and down by Honshiu to the ever-smoking Asama. Here it is joined by a line branching away to the south-west, which runs through the great Fujisan and Oshima, till it reaches the Ladrones, a distance of 1200 miles. The last line begins at, or near, the gigantic crater of Mount Aso, and extends 1300 miles through Formosa to the Philippines. Extremely basic rocks are rare, but so far as observations have gone, it may be said that the lava poured out from the northern vents is more acid in composition than the southern. All are magnetic, and lavas that will turn a compass-needle through 180° are not rare. By their decomposition, the soil of the country is in many places so filled with grains of magnetite, that a magnetized knife passed over the gravel of a garden path will be covered with a brush of this unoxidizable material.

The twelve pages devoted to the description of Fujisan are replete with interesting information. The word Fuji is said (on the authority of the Rev. John Batchelor, of Sapporo) to be a corruption of the Ainu word *Huchi*, which is the name of the "Goddess of Fire." Professor Milne ascended the mountain in 1880, and found that it was not quite extinct, as is usually supposed, for small quantities of steam were detected by him issuing through the ashes on the eastern side of the mountain just outside the lip of the crater. Von Fritsch and Ludecke have shown the lavas composing Fuji to be dolerites, and analyses by several chemists are given in this work. The beautiful and symmetrical outlines of the mountain are well known, but on the south side of the mountain there is an excrescence, at a height of 9000 feet, which was produced by the last great eruption in 1707. The recorded eruptions of the mountain are as follows:—B.C. 301, 294, or 286, and A.D. 799, 802, 864, 937, 1021, 1082, 1329, 1560, 1627, 1649, 1700, and 1707. Professor Milne records the interesting observations made by him with a tromometer or tremor-measure during a stay of five days on the top of Fuji. These observations tend to prove that the great mass of the mountain actually yields to force of wind playing around its summit. The height of Fujisan is proved by various observations to lie between 12,400 and 12,450 feet.

The authors are to be congratulated on the excellence of this first instalment of a work which promises to be one of great scientific value. J. W. J.

THE GALILEO CELEBRATION AT PADUA.

THE celebration of the three hundredth anniversary of the day on which Galileo began his labours as a Professor at the University of Padua was even more successful than had been anticipated. Its success was in every way worthy of the large number of scientific men who assembled to do honour to Galileo's memory, and of the great institution with which, as it remembers with veneration and pride, he was so intimately associated.

On December 6 the Rector, Prof. C. J. Ferraris, received in one of the courts of the old University, adorned everywhere with portraits of the most illustrious professors, delegates from the Universities, the polytechnic schools, and Italian and foreign Academies, amounting to nearly a hundred, and amongst them many of those who shed most lustre on contemporary science. The University of Cambridge was represented by Prof. George Howard Darwin, F.R.S., who also represented the Royal Society as Mr. Norman Lockyer, its delegate, had been prevented from attending. The University of Oxford by Prof. E. J. Stone; the Royal College of Physicians, London, by Sir Joseph Fayrer, F.R.S.; the Chemical Society and British Association by Prof. Ludwig Mond, F.R.S.; the Harvard University, Cambridge, U.S.A., by Prof. William James, and the Princeton University by Prof. Allan Marquand; the University of Lund by Prof. R. A. V. Holmgren; the Astronomical Observatory of Paris by its Director, Prof. F. Tisserand; that of Berlin by Prof. W. Foerster; the Polytechnic Schools of Berlin. Karlsruhe, Monaco, Brunswick, Stuttgart, by Profs, Lampe, Keller, Sohncke, Blasing, Lemcke; the University of Göttingen by Prof. Voigt; that of Budapest by Prof. Lanczy; that of Dorpat by Prof. Schmourlo; that of Lausanne by its Rector, Prof. Favey; the Academy of Paris by Prof. Gariel; the Faculty of Letters at Grenoble by Prof. de Croyals; the General Council of the Faculty at Nancy by Prof. Molk, &c., &c. There were also delegates from the towns of Florence, Pisa, Venice, and representatives from the foremost Italian Universities, Academies, and Technical Schools.

The great academical celebration took place on December 7 in the large hall of the University, in the presence of the Hon. Ferdinando Martini, Minister of Public Instruction, who represented the King of Italy. The ceremony was begun with a discourse prepared for the occasion by the Rector Magnifico, and devoted principally to a cordial expression of thanks to the King and to the Minister who represented him; to the foreign and Italian delegates; and to the ladies of Padua, who had given the University a most beautiful banner, on which were various emblems indicating the history of the University, the genealogical tree of the Galileo family, and the ancient inscription above the door of the University—*Gymnasium omnium disciplinarum*.

Next came the commemoration of Galileo by Prof. Antonio Favaro, who has for nearly fifteen years devoted himself almost exclusively to the study of the life and works of Galileo, and to whom was confided by the Government the care of the national edition of the philosopher's works, under the auspices of the King of Italy. The orator kept his discourse within the limits marked out for him, speaking chiefly of Galileo at Padua. Constrained to leave the University of Pisa, Galileo had been welcomed in that of Padua, where he found the "natural home of his mind," a "theatre worthy of his talents." The conditions at Padua at that time were eminently favourable to Galileo's work, for the Venetian

Senate granted the lecturers the utmost liberty, and experimental methods, which could not be learned from books, had been practised at the University for more than a century. Galileo had many opportunities for the development of his genius, both in the lecture-room and in the home, in the preparation of scientific publications, and in the workshops of scientific instrument-makers both in Padua and Venice. To Venice he frequently went, attracted thither by the means it afforded him for study; by that grand arsenal which had already been sung by Dante, and which in his reputed Dialogues is spoken of by Galileo with admiration; but above all by the advantages he derived from scientific intercourse with eminent men who resided in the dominion. The culminating point of the discourse was naturally reached when the orator had to deal with the invention of the telescope, and with the astronomical discoveries made by means of it, the immediate result of which was the recall of Galileo to Tuscany. This did not aid Galileo in his glorious career, or help to protect him from the attacks which were for a long time made on him by invidious adversaries. Even some of his own servants changed at once to implacable and dangerous enemies, and at last he was involved in all the miseries which sprang from the memorable lawsuit. This led the orator to recall the fact that when the clouds assumed their most threatening aspect, the Venetian Republic, forgetting with real magnanimity whatever resentment it might have felt at Galileo's abandonment of his chair at Padua, offered to re-appoint him, and to print at Venice the work which had brought upon him so much trouble. He said also that a pleasant memory of Padua must have passed through the mind of the prisoner of the Holy Office, when there came to him his only comfort, the message from the favourite of his childhood, the nun who in Padua had tenderly cared for him during the first ten years of his youth.

After Prof. Favaro's oration discourses were delivered by the foreign delegates, Holmgren, Fayrer, Darwin, Tisserand, Lampe, Keller, Foerster, Sohncke, Blasing, Lemcke, Farey, Lanczy, Schmourlo, and by Italian delegates, Nardi-Dei, Mantovani-Orsetti, and Del Lungo. Then followed the conferring of University honours, of which seven had been set apart by the Council for seven men of science, one for each nation, all distinguished for their devotion to the studies in which Galileo excelled, viz. Schiaparelli, Helmholtz, Thomson, Newcomb, Tisserand, Bredichir, and Gylden. The degree of philosophy and letters was given to the Minister Martini; of natural philosophy, and philosophy and letters, to the leading delegates. The ceremony was closed by the inauguration of a commemorative tablet in the large hall.

Of the other festivals connected with the celebration it would be out of place to speak here, and it will be better to add a list of the publications which have been issued on the occasion. The oration read in the Great Hall by Prof. Favaro has been published, with the addition of twenty-five facsimiles of documents containing the various decrees of the Senate concerning Galileo, the date of the early prelections given by him at regular intervals, several autographic records of Galileo, chosen in order to give a more exact idea of what are the most precious materials for his biography, the frontispieces of the various publications issued by Galileo, or relating to the time of his sojourn in Padua, the geometric and military compass, the writing presenting the telescope to the Doge, and the first observations of the satellites of Jupiter. A portrait of the great philosopher, from a painting which represents him at the age of forty, taken in 1604, is prefixed.

By favour of the University there have also been published two other works, one containing all the notices of the studies at Padua in 1592, the other proving which was the house inhabited by Galileo and the place in which he made his astronomical observations. The ancient Academy of Padua, among whose founders Galileo is numbered, has issued a publication in which are collected several works dedicated to his memory; and the students of the University have sought to perpetuate the remembrance of this festival by the publication of a "unique number," bringing together all the documents relating to the sojourn of Galileo in Padua, collected from all quarters. These publications will serve as suitable memorials of a great and most interesting celebration.

ANTONIO FAVARO.

SIR RICHARD OWEN.

IT is with great regret that we record the death of Sir Richard Owen He died on Sunday, after a lingering illness, at Sheen Lodge, Richmond Park, in his eighty-ninth year. In publishing his portrait in the series of "Scientific Worthies" (NATURE, vol. xxii. p. 577) we have already presented an estimate of his work and of his place in the history of science. It is only necessary now, therefore, to recall some of the leading facts of his career.

He was born at Lancaster on July 20, 1804, and received his early education at the grammar school of his native place. Afterwards he matriculated at the University of Edinburgh as a medical student. In 1825 he joined the medical school of St. Bartholomew's Hospital, London, and in 1826 he took his diploma at the Royal College of Surgeons. His professional studies having been completed, he began to practise in Serle Street, Lincoln's Inn Fields; but the bent of his mind was towards purely scientific investigation, and he soon had a good opportunity of exercising his powers. Dr. Abernethy, with whom he had acted at St. Bartholomew's as a dissector, had recognized his ability; and, in accordance with the advice of this famous surgeon, he was invited in 1828 to undertake the task of cataloguing the Hunterian collection at the Royal College of Surgeons. The invitation was accepted, and in 1830 the first catalogue of the invertebrate animals in spirits was published. In the same year Owen read at the first meeting of the Zoological Society's committee of Science a valuable paper on the anatomy of the orang-utan, and afterwards he made many important contributions to the Society's Transactions and Proceedings. He was also well known as a reader of papers before the Medical Society of St. Bartholomew's and the Medical and Chirurgical Society of London. In 1832 appeared his well-known essay on the Pearly Nautilus (*Nautilus Pompilius*), in which he gave most striking proof of his power of interpreting the facts of natural history in a thoroughly philosophical spirit.

Before he was thirty years of age Owen had achieved so good a reputation that in 1834 he was appointed to the newly-established chair of comparative anatomy at St. Bartholomew's Hospital. Two years afterwards he succeeded Sir Charles Bell as professor of anatomy and physiology at the Royal College of Surgeons, and he was elected to the newly-established Hunterian professorship at the Hunterian Museum. He also became conservator of the Hunterian Museum on the death of Mr. Clift, whose daughter he had married. He had gradually been withdrawing from the practice of his profession, and ended by devoting the whole of his time and energy to scientific work.

His connection with the Royal College of Surgeons lasted for twenty years, and during this period he achieved results which placed him in the front rank of original investigators. In the article to which we have referred we have already indicated the nature and importance of these results, and need not go over the same ground again. It must suffice to mention the completion, in five volumes, of his catalogue of the Hunterian

collection; his "Odontography"; his Lectures on Comparative Anatomy and Physiology; his "Archetype and Homologies of the Vertebrate Skeleton"; his memoirs on "The Nature of Limbs" and on "Parthenogenesis"; his monograph of British fossil reptiles; and his papers on the fossil birds of New Zealand, and on some fossil mammals of Australia. In 1856 he was appointed Superintendent of the Department of Natural History in the British Museum. How splendidly he fulfilled the duties of this position all the world knows. He fought steadily and earnestly to obtain proper accommodation for the magnificent collection placed under his charge, and to him, more than to any one, Great Britain owes the fact that this particular set of her scientific treasures is now so securely preserved and so finely displayed. The practical duties of his office were not allowed to interrupt his scientific researches, and year after year he continued to give fresh evidence of the astonishing range of his knowledge and of his remarkable capacity for far-reaching and brilliant generalization. Among the writings of this period are his Manual of Palæontology, and his memoirs on the classification and geographical distribution of mammals, on the British fossil reptiles of the Liassic formations, ichthyosaurs and plesiosaurs, on the British fossil cetacea of the Red Rag, on the British fossil reptiles of the Mesozoic formations, pterodactyls, and on the fossil reptiles of South Africa.

In 1883 he resigned his official position, but he did not cease to interest himself in the studies in the prosecution of which he had displayed so commanding a genius. In 1884 he issued in three volumes his great "History of British Fossil Reptiles," and until a comparatively recent date he submitted to the Royal Society from time to time papers embodying the more important results of his labours.

In the course of his long career Owen did much good service as a member of various Commissions, and it is scarcely necessary to say that honours of many different kinds were conferred upon him. About these matters we have given all necessary information in our previous article. Owen was very far from being content merely with the collection and classification of facts; he sought also to bring out the ideas in which his facts seemed to him to find their ultimate significance. He was unable to adopt the theory of evolution as presented by Darwin, but his researches did much to prepare the way for the general and rapid acceptance of Darwin's hypothesis, since it was felt that there must be some strictly scientific explanation of the affinities by which he had shown vast groups of animal forms to be allied to one another. Apart altogether from its speculative aspects, his work is universally acknowledged to be of high and enduring value, and there can be no doubt that he will rank among the strongest and most impressive figures in the intellectual history of the nineteenth century.

He desired that his body should be buried beside that of his wife in Ham Churchyard, and his wish is, of course, to be complied with. At the funeral, which will take place to-morrow (Friday), there will be representatives of all the learned societies with which he was connected.

NOTES.

The following memorial, numerously signed, has been presented by Sir Henry Roscoe to the Right Hon. the Earl Cowper, Chairman of the Royal Commission on the Gresham University:—The undersigned desire hereby respectfully to record their strong opinion that the foundation of a Teaching University for London, without due provision being made for higher Education and original Research, would be unworthy of the Metropolis, and would entail the neglect of an admirable opportunity for promoting the advancement of Science and Learning. The signatures cannot fail to command attention. The following learned Societies are represented by their Presidents:—The Royal Society, the British Association for the Advancement of Science, the Royal Dublin Society, the Royal Society of Edinburgh, the Iron and Steel Institute, the Physical Society, the Institution of Electrical Engineers, the Institute of Mechanical Engineers, the Chemical Society, the Royal Horticultural Society, the Pharmaceutical Society of Great Britain, and the Institute of Chemistry of Great Britain and Ireland. Eton College, Harrow School, Rugby School, and St. Paul's School are represented by their head-masters. There are also representatives of the University of Oxford, Cambridge, Edinburgh, Glasgow, Aberdeen, and St. Andrews, the Victoria University, the British (Natural History) Museum, the Royal College of Science, London, University College, London, Mason College, Birmingham, Durham College of Science, Firth College, Sheffield, University College, Dundee, University College, Bristol, City and Guilds of London Central Institution the Royal College of Science, Dublin, and the Pharmaceutical Society of Great Britain. A special group of signatures consists of the names of a number of Fellows of the Royal Society.

Sir Joseph Lister, Sir Henry Roscoe, and Prof. Ray Lankester, will represent the Royal Society at the Pasteur celebration in Paris on the 27th inst. Captain Abney has been invited to represent the Society at the 150th anniversary of the American Philosophical Society in May 1893.

We are glad to see that a movement has been started for the purpose of securing that due honour shall be done to the memory of Jean Servais Stas, one of the most illustrious of modern chemists. It is proposed that a new edition of his writings shall be issued, his memoirs, notes, and reports being grouped in their proper order, and that a commemorative monument shall also be erected. An influential committee, representing science in all parts of the world, has been appointed to take the necessary steps. Subscriptions will be received by M. L. Errera, 1, Place Stéphanie, Brussels.

The Committee of the International Electrical Exhibition to be held at Milan in 1894 proposes, according to *La Lumière Electrique*, to offer a prize for the most important invention or discovery in the province of electricity, especially in connection with the transmission of energy to a great distance, and its distribution and transformation for industrial uses.

Successful experiments have been made in France relative to the introduction of telephones for use in warfare. The telephonists are organized in sets of two men, each set being provided with equipment for a mile line. The very simple receiving and transmitting apparatus are attached to the military cap, and the wire is on reels in a sort of breast-plate, the whole being so light that a man's ordinary equipment weighs less than six pounds.

The tunnel at Niagara Falls is finished, and the power plant will be in operation by next March. It is expected that a current of 45,000 electric horse-power will be transmitted from there to Buffalo, and 30,000 to other points.

M. Maurice Mallet, in *L'Aéronaute*, describes what he claims to be the longest balloon ascent on record. His balloon, "Les Inventions Nouvelles," started from the gasworks of La Villette, Paris, on October 23, and the voyage terminated at Walhen, in Central Germany, at 6 a.m. on the 25th, after a total journey of 36 hours 10 minutes above ground. The flight was interrupted several times by the snow which fell in the higher regions of the atmosphere. When lower strata were reached, the snow melted, and the balloon regained its ascending power. During one of these descents it was stopped and examined by

a Prussian *gendarme*, who had followed it at a gallop for some distance. The route passed over part of Belgium, the Taunus, and the Odenwald, and the towns of Metz and Frankfurt were recognized in passing.

THE "Annals of the Harvard College Observatory" contain a discussion by H. H. Clayton of the cloud observations made at Mr. A. L. Rotch's observatory at Blue Hill, Massachusetts. One of the most noticeable facts brought out by the measurements of cloud heights and velocities, which have been conducted with great care, is the difference in height between the same clouds in summer and winter, the clouds, with few exceptions, being lowest in winter. The bases of the cumulo-nimbus clouds, however, are generally lower in summer, while, at the same time, their tops are higher than in winter. The heights of the different clouds were found to maintain an almost constant ratio to each other. The mean velocities recorded showed that the entire atmosphere moves twice as fast in winter as in summer. The mean velocity of the highest clouds in winter was about 100 miles an hour; the extreme velocity amounted to 230 miles an hour, from which it appears that the upper currents are much more rapid over America than over Europe, which possibly explains the greater velocity of the storms in America. As regards the directions of cloud movement, the tables show that from the highest clouds to the earth's surface, the prevailing wind is west; above 4000 metres more than 90 per cent. of the observations show the clouds from some point between south west and north-west inclusive. In the cirrus and the cumulus regions, and near the earth's surface, the prevailing direction is from a little north of west, but in the intermediate levels, from a little south of west, the excess of the southerly component in these regions being possibly due to the influence of cyclones.

THE weather during the past week has been generally very dull, and scarcely any rain has fallen over the southern parts of the kingdom. Butween Friday and Monday there were several depressions to the northward of our islands, passing in an easterly direction, which caused very severe gales and high seas on the coasts of Scotland, the difference on pressure on Sunday between the north and south of our islands being more than an inch. During the first part of the period the temperature was unusually high for the season, the maxima exceeding 55° in some parts, and the night minima were occasionally higher than the average daily maxima for the month; subsequently, however, a decided fall occurred, with fog and mist in most parts of England, while in Scotland hail and sleet showers were experienced. The *Weekly Weather Report* of the 17th instant shows that for that period the temperature was from 2° to 4° above the mean. Rainfall exceeded the mean in the north of Scotland only, and just equalled it in the north of Ireland; in all other parts there was a deficiency. Bright sunshine was much less prevalent than during the preceding week, although in most parts of England the amount exceeded the average.

PROF. COLE writes from Dublin that the afterglow in the west and zenith on Saturday, December 17, was of a superbly brilliant character. Mr. R. Langton Cole observed that in London on December 15 the whole sky was covered by the glow, which was deeper all round towards the horizon.

AN interesting lecture on "Water and Water Supply" was delivered last week at the London Institution, by Major L. Flower, of the Sanitary Institute. As an instance of the important part which water played in the economy of nature, he mentioned that if a man weighing 140 lbs. were placed under a hydraulic press and squeezed flat, the result would be 105 lbs. of water and only 35 lbs. of dry residue, which was a fact for conceited people to reflect upon. Major Flower gave some interesting facts about the rainfall of England. It is, of course, highest in mountainous districts, the maximum fall being found in Cumberland, where the record for six years shows an annual rainfall of 165 in. The lowest in England is between Biggleswade and Bedford, where it reaches only 20 in. London and the east coast average about 25 in. Speaking of drinking water, Major Flower said the best way to get it was to bottle it at the fountain-head and have it delivered in bottles, which had been done already and might be done to a greater extent in the future.

MR. W. F. HOWLETT writes to us from Pahiatua, New Zealand:—"Can you inform me what is now sold in England as gum arabic? I used to be able to buy a soluble gum; what I get now is the same in appearance, but it will not dissolve. It swells up, truly, but will not form a homogeneous filterable solution. It would be a great boon to small buyers if such things were sold under their proper names. Am I right in supposing that since the Soudan trouble gum arabic has disappeared from commerce?"

A VERY interesting report on artesian boring, by Mr. J. W. Boultbee, is included in the volume containing the annual report of the Department of Mines and Agriculture, New South Wales, for the year 1891. Mr. Boultbee shows that, as a rule, artesian waters are suitable for irrigation purposes, only those heavily charged with salt or alkaline matters being unsuitable; and he can see no reason why such irrigation should not be an element of immense value, deserving the utmost consideration in connection with the development of that north-western portion of the colony, where the fertility and recuperative powers of the soil are so wonderfully illustrated by the growth of feed after rainfall at the proper season. The average quantity of water required for the irrigation of grain crops, based upon the experience of other countries, may be roughly estimated at 72,600 cubic feet, or 543,485 gallons per acre. One inch of rain would equal 3630 cubic feet, or 22,622 gallons per acre. A rainfall of 20 inches would therefore yield 72,600 cubic feet, or 543,485 gallons per acre. 640 acres would consequently require 46,464,000 cubic feet, or 347,830,400 gallons upon them as an equivalent to 20 inches of rain. When it is considered that the flow per diem from the Native Dog Artesian Bore, 45 miles from Bourke, is approximately 2,000,000 gallons per diem, or 730,000,000 gallons per year, it will be seen that upon the foregoing basis a supply of water equal to a rainfall of 40 inches per annum, per 640 acres is available, or that an area of considerably over 1280 acres can be supplied with water equalling a rainfall of 20 inches per annum.

THE Cambridge Local Lectures Syndicate have just issued an announcement of their next Summer Meeting of University Extension students, to be held at Cambridge in August, 1893. The programme is a large and varied one, and a number of well-known lecturers have already promised their services. Among the scientific lecturers we notice the names of Sir Robert Ball, Sir H. E. Roscoe, Mr. Pattison Muir, and several of the best known of the Cambridge Extension lecturers. Cambridge has always laid great stress on the importance of providing, as far as possible, practical work in science as well as theoretical teaching. It has seldom been found possible to arrange much practical work in connection with the lectures given in the provinces, chiefly on account of the difficulty of finding laboratory accommodation. But students who can spare a fortnight—or, better still, a month—have now the opportunity of coming to Cambridge and seeing, at any rate, something of the resources of the University laboratories. Even two or three weeks' work in a well-equipped laboratory may easily be a revelation to a student who has hitherto learnt his (or her) science from books or lectures. The laboratory work has always formed an important and highly appreciated part of the

Cambridge Summer Meetings. Next year no less than five practical courses are promised, viz. in physics, chemistry, botany, physiology, and palæontology, thus providing for a considerable variety of taste, and for the accommodation in the laboratories of a fairly large number of scientific students. Another feature in the programme is an entire novelty. It is proposed to give a series of short courses of lectures on the growth of various sciences—astronomy, physics, chemistry, and geology—to illustrate from different points of view the methods by which discoveries are actually made, and science makes progress. These will be accompanied by a short theoretical course on scientific method. The sciences selected only cover a small portion of the whole field, and some aspects of scientific method—such as classification—will obviously scarcely be represented. The organic sciences generally are left out, and may possibly form the groundwork of a similar scheme on some future occasion. The idea of illustrating scientific method by the history of science is a familiar one, and is the basis, for example, of Whewell's great books on "The Philosophy and the History of the Inductive Sciences." Few men, however, possess the encyclopædic knowledge of science which Whewell had, and the progress of science since his day would make such a task as he undertook well-nigh impossible for a more modern writer. The Cambridge Syndicate do not attempt to find a Whewell, but hand over the history of each science to competent specialists, and hope to give real unity to the whole by the lectures on method, in which the lessons taught by the history of the various sciences will be brought into a focus, and made to lead up to general principles. The experiment is certainly an interesting one, and we shall watch with some interest to see how it succeeds. The programme includes also lectures on history, literature, art, and other subjects. But we have dwelt only on the science as being of special interest to our readers.

In the Herz oscillator, as used hitherto, the spark discharge of a Rhumkorff has been produced in air between two balls. MM. Sarasin and de la Rive lately thought (*Arch. de Sciences*) to place the balls in an insulating liquid, and they find that this gives a more intense effect in the resonator. Olive oil does best; oil of turpentine, liquid paraffin, and petroleum were also tried. Placed near the oscillator the resonator gives quite a bright spark, and at about 30 ft. distance, with a resonator of large diameter, the spark is strong enough to be visible a good way off.

Attempts are being made to create a silk-producing industry in the district of Nicolaieff, in South Russia: and, according to the British Vice-Consul at Nicolaieff, the result is not unlikely to be satisfactory. He says that the mulberry tree, for the growth of which the soil and climate are well adapted, flourishes wherever it is planted, and that with very little trouble or expense every little plot of ground, now yielding nothing more than a crop of weeds, might in a short time be transformed into a remunerative feeding-ground for the silkworm. The matter has been taken in hand by a society, and every encouragement is given to the peasants and poorer classes to take advantage of the opportunities provided for them. If seriously followed up, the scheme may, the Vice-Consul thinks, prove a source of revenue to many a poor family, and eventually be the means of establishing a large and flourishing industry.

At a recent meeting of the Trinidad Field Naturalists' Club there was some discussion as to the question whether the bite of the tarantula (Mygale) spider is poisonous. Mr. C. W. Meaden, writing to the Club's journal on the subject, describes an incident which came under his own observation. Early in the present year he had a gang clearing some land after burning, and on visiting them one afternoon he saw a black tarantula dart from a heap of bush and deliberately bite one of the prisoners on the heel and then scamper away, which it did with safety to itself, although chase was made after it. The spider seemed to be in an angry mood at being disturbed in a favourite haunt for food and shelter. The bite drew blood, about two or three drops. A Trinidad labourer's foot is thick enough almost to resist an auger, yet the spider managed to penetrate, so it may safely be asserted it was in earnest. Immediately the bite was given a shout went up, "The man is bitten by a big black spider—a tarantula!" This made the bitten one almost frantic with fright, and he cried out piteously, "Me God, me go die in gaol, me God," &c. Mr. Meaden took him to the infirmary, some 300 yards distant, and the sufferer carried his heel in his hand, *i.e.* hopped all the way. His foot was fomented with hot water, and spirits of ammonia were applied, with the addition of a little liquid ammonia, and he received a dose of ether mixture. About two hours afterwards he ate his dinner heartily and slept well at night. He complained of no pain in the morning, and went to work as usual. There was no local swelling or inflammation, and but little pain at any time. Fright was the only ill effect.

Some interesting results in application of cold have been recently recorded. Thus M. d'Arsonval has found that while with rising temperature, microbes die before soluble ferments, with lowered temperature the opposite occurs. The invertine of beer yeast cooled to -40°C., does not lose its power, but it is destroyed as a ferment at -100°. On the other hand, the yeast itself cooled to -100° is still active. M. Raoul Pictet has lately observed that at -150° all chemical reaction is suppressed. Thus, if sulphuric acid and potash are brought together at this temperature, they do not combine. Litmus paper, introduced, keeps its colour. Curiously, it is possible to restore their energy to these inert substances, by passing an electric current, and the current passes readily whatever the substances; at -150° all bodies are good conductors. The disappearance of affinity at a low temperature can be utilized to get absolutely pure substances, and M. Pictet has thus obtained alcohol, chloroform, ether, and glycerine.

Some good notes on the Shuswap people of British Columbia, read before the Royal Society of Canada by Dr. George Dawson, F.R.S., are now printed in the Society's Transactions, and have also been issued separately. In an interesting section on the superstitions of the Shuswaps he notes that they have a singular idea about certain small lizards. A man who sees one of these creatures is supposed to be followed by it wherever he may go during the day, till at length, when he is asleep during the following night, it finds him, and entering his body, proceeds to eat out his heart, so that he quickly dies. The late Mr. Bennett, of Spallumsheen, told Dr. Dawson in 1877 that the Indians employed by him in making a ditch for purposes of irrigation, on coming into camp in the evening, would jump several times over the fire in order to lead the possibly pursuing lizard to enter the fire and be destroyed in attempting to cross. He also noticed that they carefully tied up the legs of their trousers when retiring. If while at work during the day they saw one of these little lizards, which appeared to be abundant in that locality, it would be caught in a forked twig, the ends of which were then tied together with a wisp of grass and the butt end of the twig afterwards planted in the soil. Thus treated, the lizard soon died and become a natural mummy. If during the progress of the work any one found and carelessly tossed aside one of these lizards, the Indians would throw down their tools and search diligently until they found it, and secured it in the manner just described. Dr. Dawson thinks that this superstition must be widespread among the Indians, for it was afterwards related to him in identical form by a man of the Nicola River, who further pointed out a small lake, singularly

situated on the summit of a high ridge about a mile and a half south of the mountain named Za-kwās'-ki, as a noted resort—possibly the only place known to the man—of this peculiar animal. He described it as being a few inches in length and nearly black. Za-kwās'-ki, to which other stories attach, is south of Nicola River, at the source of the Nicoamen River.

A COMMON impurity in many seeds which are used as food for live-stock is the seed of corn-cockle (*Agrostemma githargo*). Notably is this the case on the Continent, and especially in Hungary, where the refuse from the machines used in cleaning grain consists chiefly of cockle-seed, and is largely used in feeding swine. It appears, as a rule, to have no ill-effect upon these animals. Upon other animals, however, it sometimes has serious and even fatal effects, especially upon calves and dogs. According to Kobert (*Landw. Centralblt. Provinz Posen*, 19) it would appear that the seeds contain a glucoside—saponin $C_{32}H_{54}O_{18}$,—which acts as a poison either when eaten in the form of cockle-seed or when introduced into the blood. Various animals are affected in different degrees, but dogs, cats, and birds soon die when fed upon the seed. The poison decomposes the blood, dissolving the red corpuscles, and also destroys the sensitive albuminoid portion of the nerve elements. Heating to 50° C. decomposes the saponin, and renders the seed harmless. Since this glucoside is found to lie only just below the surface of the seed, Kobert suggests that the seed should be coarsely ground and the outer husk separated; to cook the meal would be a still safer precaution. A good deal of cockle-seed comes into the port of Hull, chiefly, it is presumed, amongst grain which has not been screened. From such seeds as linseed it is removed by screening before pressing, but it is too often found in the cake which results after the oil is expressed from the linseed. A considerable quantity of corn-cockle is handled in Hull, whatever its ultimate destination may be, and it sometimes occurs in feeding-stuffs in far too large a percentage to be considered as an accidental impurity. Its use in admixture (as impurity or otherwise) with other feeding-stuffs is strongly to be deprecated so long as there is the slightest risk attending its consumption by any domestic animal. Its detection is very easy, the peculiar rough husk of the seed being characteristic; the husk, after clearing with dilute sulphuric acid, and then with caustic soda, and examined under a low power of the microscope, will exhibit dark-red convoluted markings which distinguish it clearly from the husk of any other well-known seed.

IT is a well-known fact that sea-anemones have a sense by which they recognize food. This has been studied recently by Herr Nagel at the Zoological Station in Naples, and he has endeavoured to localize it. Among other experiments, a small piece of a sardine was brought carefully to the tentacles of one of these animals; the tentacle first touched, then others, seized the food and surrounded it, and the morsel was swallowed. A similar ball of blotting-paper saturated with sea-water, brought near in the same way, was not seized. If, however, the ball was soaked in the juice of fish, it was seized with the same energy as the piece of fish, but often liberated again after a time without being swallowed. Blotting-paper saturated with sugar acted like the other, but more weakly. If saturated with quinine, it was refused, the tentacles drawing back. On the outer surface of the body, as also in the part between the tentacles and the mouth, quinine had no effect, nor had coumarin, vanillin, or picric acid. When a piece of meat was placed in or near the mouth of a widely-open animal, no notice was taken of it; it was only seized when the tentacles were touched. Thus the sense of taste seems to be in these alone. Cutting the tentacles did not evidently give pain, but these organs appeared sensitive to heat and to touch, so that they appear to be the seat of three senses.

MR. JOHN MURRAY has published a fourth edition of Dr. W. Fream's "Elements of Agriculture." The work was originally issued at the beginning of the present year, and two editions were sold out before the end of January. The third edition has for some time been out of print. The book has now been thoroughly revised, and enriched with a completely new set of illustrations.

A NEW edition of Dr. John Casey's "Sequel to the First Six Books of the Elements of Euclid" has been issued as a volume of the Dublin University Press Series. The work has been edited by Prof. P. A. E. Dowling, by whom it has been carefully revised and considerably enlarged. The editor has obtained much valuable aid from Prof. Neuberg, of the University of Liège.

MESSRS. BLACKIE AND SON have issued a second edition, revised and enlarged, of Mr. J. McGregor-Robertson's "Elementary Text-book of Physiology."

A FURTHER communication concerning the nature and properties of hydroxylamine, NH_2OH, is contributed to the *Recueil des travaux chimiques des Pays-Bas* by M. Lobry de Bruyn, whose isolation of the free base was described in our note of vol. xlv. p. 20. It may be remembered that pure hydroxylamine was found to be a solid substance, crystallizing in colourless thin plates or needles, which are extremely deliquescent. So powerful indeed is the affinity of hydroxylamine for water, that the crystals rapidly dissolve when exposed to the air, in the moisture attracted. The crystals melt at a temperature of 33°, and the liquid boils at 58° under the reduced pressure of 22 millimetres. If the liquid is heated under ordinary atmospheric pressure in contact with the air, it explodes with great violence when a temperature between 60° and 70° is attained; if the experiment is carried out in a vessel from which air is excluded, the liquid may be heated as far as 90° without accident, regular decomposition into gaseous products occurring at this temperature. Explosion, however, usually follows at once if this temperature is much exceeded, and generally after a short time if the source of heat is removed as soon as the thermometer has reached 90°, inasmuch as the decomposition which is induced at this temperature is accompanied by evolution of heat. The crystals are without odour. They react with considerable violence with the halogen elements, the reaction in the case of chlorine being accompanied by production of flame; the products do not appear to have been investigated as yet beyond ascertaining the presence among them of the halogen acids. Metallic sodium also vigorously attacks hydroxylamine, brilliant incandescence occurring. Warm zinc dust reduces it to ammonia so rapidly, that if any considerable quantities are employed a violent explosion follows. Highly oxidized compounds, such as potassium permanganate, chromates, bichromates, or chromic acid react with crystals of hydroxylamine, as may be expected, in a most energetic manner, brilliant flame being produced often accompanied by detonation. Chlorates, perchlorates and bromates behave similarly in the presence of a drop of sulphuric acid. Hydroxylamine liberates iodine from iodic anhydride, and rapidly reduces iodates to iodides. Dehydrated sulphate of copper inflames in contact with the crystals of the base, and powdered nitrate of silver is reduced to metallic silver. Addition of trichloride or pentachloride of phosphorus to the crystals likewise brings about ignition. Hydrogen peroxide oxidizes hydroxylamine to nitrous acid. These reactions, selected from a large number which M. de Bruyn describes, amply demonstrate the remarkable chemical energy with which anhydrous hydroxylamine is endowed. It is interesting to learn that the melted substance is capable of dissolving a considerable volume of ammonia gas. Moreover, carbon dioxide and sulphuretted hydrogen are so soluble in melted hydroxylamine that

viscous liquids are produced which remain liquid even at $-10°$. As regards the preparation of the base, M. de Bruyn has now succeeded in obtaining a hundred grams of the pure crystals from a little more than a kilogram of the hydrochloride, by the method described in our previous note above referred to.

THE additions to the Zoological Society's Gardens during the past week include a red and yellow macaw (*Ara macao*) from Central America, presented by the Rev. T. N. Talfourd Major; two gold pheasants (*Thaumalea picta* ♀ ♀) from China; an Alpine Chough (*Pyrrhocorax alpinus*), European, purchased.

OUR ASTRONOMICAL COLUMN.

COMET HOLMES (NOVEMBER 6, 1892).—The following ephemeris, taken from *Astronomische Nachrichten*, No. 3131, gives the position for Comet Holmes for the ensuing week:—

Berlin, Midnight.

1892.	R.A. (app.). h. m. s.	Decl. (app.). ° ′	Log *r*.	Log Δ.
Dec. 23 ...	0 55 44 ...	+34 19·2		
24 ...	56 37 ...	16·0 ...	0·4050 ...	0·3049
25 ...	57 31 ...	12·9		
26 ...	58 27 ...	10·0		
27 ...	0 59 24 ...	7·2		
28 ...	1 0 22 ...	4·5 ...	0·4073 ...	0·3167
29 ...	1 1 21 ...	34 1·9		

M. Deslandres, in *Comptes rendus* for December 12 (No. 24), informs us that on November 21 he obtained a photograph of this comet between 10h. 40m. and 11h. 20m. Paris mean time, showing distinctly "un commencement de dédoublement." Owing to the bad weather no other negatives were taken until December 10, but although the time of exposure was an hour, the comet's impression was not obtained, thus confirming the present eye observations that its intensity is slowly decreasing.

COMET BROOKS (NOVEMBER 20, 1892).—The following ephemeris of Comet Brooks is that obtained by Berberich, and varies a little from that given last week, as will be seen by comparing the values for December 22, with those given last week:—

Berlin, Midnight.

1892.	R.A. h. m. s.	Decl. ° ′	Log Δ.	Log *r*.	Br.
Dec. 22...	14 26 9 ...	+42 50·2			
23...	14 33 28 ...	44 40·4 ...	9·9211 ...	0·0880 ..	5·59
24...	14 41 35 ...	46 34·4			
25...	14 50 41 ...	48 31·6 ...	9·9013 ...	0·0861 ...	6·18
26...	15 0 55 ...	50 31·4			
27...	15 12 26 ...	52 32·9 ...	9·8838 ...	0·0845 ...	6·75
28...	15 25 30 ...	54 34·5			
29...	15 40 21 ...	56 34·4 ...	9·8694 ...	0·0831 ...	7·26

SWIFT'S COMET.—*Knowledge* for December 1 contains three most interesting photographs of Comet Swift, taken by Prof. Barnard at the Lick Observatory on April 4, 6, and 7 respectively. These photographs, which are obtained from the original negatives after an enlargement of 2¼ times, show what good photographic work can be done even with small instruments when exposures are somewhat lengthened. In this case a 6-inch Willard lens of 31 inch focal length was strapped on to the tube of a 6½-inch equatorial, and the exposures given amounted to 60, 65, and 50 minutes. The ordinary driving-clock, combined with a slight hand movement at the eye end, were all that was required to compensate for the diurnal and proper motion of the comet. The star trails on the plates pointed out then the comet's proper motion. Although these photographs were taken at such short intervals the changes recorded are most striking, the pictures bearing very little likeness to one another. On this point Prof. Barnard says: "Had they been drawn by the most competent observer, most astronomers would leave their remarkable differences to the unskilful hand of the artist, for there is absolutely no resemblance among them." The photographs here referred to are from a series taken at Mount Hamilton, and in examining them he mentions that in the case of this comet he has been led to forcibly believe that in a comparatively short period there occurred a rotation of the tail "upon an axis through the nucleus."

ULTRA-VIOLET SPECTRUM IN PROMINENCES.—In the current number of the *Memorie della Società Degli Spettroscopisti Italiani*, Prof. G. E. Hale communicates a note on some photographs of the ultra-violet region in the spectra of solar prominences. On October 15 at 3h. 15m. a photograph of the spectrum of a metallic prominence was obtained, which contained as many as 74 bright lines in the ultra-violet between wave-lengths 3970 and 3630. The photograph, besides displaying all the lines previously recorded by Prof. Hale and M. Deslandres, contained 32 additional lines which had not been previously known. The following table shows their respective wave-lengths, which are to be regarded yet as only approximate:—

λ		λ		λ
3964	...	3863	...	3724·3
3956·9	...	3850·5	...	3716·9
3945·2	...	3813·5	...	3710·3
3938·1	...	3774	...	3699·5
3913·5	...	3767·1	...	3683
3965	...	3758	...	3681
3895·5	...	3757	...	3679·5
3893·8	...	3749·7	...	3674·2
3891	...	3741·7	...	3662·2
3878·8	...	3733·3	...	3647·8
				3632
				3630·8

Besides these lines the photograph shows traces of the lines λ 3807·2, 3802, 3764, 3763, 3758·2, 3709·5, 3707·8, 3676, 3643.

EPHEMERIS FOR BODIES MOVING IN THE BIELA ORBIT.—In *Astronomical Journal*, No. 281, Dr. Chandler communicates an ephemeris for the use of those wishing to search for bodies which may be moving in the orbit of Biela's comet. The ephemeris is given for every eight days. It is based on the orbit obtained by Michez, who calculated the principal perturbations up to 1866. In the present computations Dr. Chandler has not taken into account any disturbance that may have been produced by the proximity of the planet Jupiter, or any perturbation that might have ensued from an approach to our earth. The values are given up to the end of February, 1893.

MADRAS MERIDIAN CIRCLE OBSERVATIONS.—The Government of Madras has lately issued the results of observations of the fixed stars, made with the meridian circle during the years 1874–76. During this interval no change whatever was made either in the instrument or in the methods of reduction. The volume gives the instrumental corrections for these years, the separate results of observations for each year, with the mean positions of the stars brought up to January 1 of each year, and corrections to the Nautical Almanac stars for the period in question.

THE JUBA RIVER.

AT the meeting of the Royal Geographical Society on Monday evening, Commander F. G. Dundas, R.N., read a paper describing his ascent of the Juba river. This was the first serious attempt to explore the river since Von der Decken's ill-fated expedition in the *Guelph* in August, 1865. The stern-wheel steamer *Kenia*, belonging to the Imperial British East Africa Company, under the command of Captain Dundas, crossed the bar of the Juba on April 25, 1892, an operation of much danger, as the vessel was exposed broadside on to heavy rollers; the depth at high water is only one fathom, and the water swarms with sharks and crocodiles. The coast Somalis lined the bank with hostile movements as soon as they saw that the vessel was to go up the river, and detained the expedition for a fortnight, until a message was sent to the head chief, the Sultan of the Ogaden Somalis. It was July 3 before amicable arrangements could be made, and the expedition fairly started. The Somalis met with everywhere were very strict Mohammedans, and secluded their women, but a number of Galla slave-girls were seen amongst them. There were few villages, Hajowan and Hajaualla opposite each other near the mouth being the only large ones until Munsur, 360 miles, and Bardera, 387 miles from the sea, were reached. The lower reaches of the river were very winding. On one occasion Captain Dundas observed a stream flowing parallel to the river he was on, and going across to see it recognized the landmarks as those

he had passed three hours before. The Waboni tribe, who live by hunting, and use the bow and arrow, occupied the thick woods of the lower river. Above them the curves became more gentle, and the Gusha district was reached, where the people cultivated the land, which was cleared by burning; and for a hundred miles the *Kenia's* furnaces were fired with the dead trees which had been killed, but left unburnt by the fire. Cotton is cultivated as well as food plants, and there is a primitive system of weaving. Above Bilo, and about 100 miles from the sea, a branch was found to run off from the main river to the south-west through very dense forests. This is probably the Sheri, which reaches the sea midway between Lamu and Kismayu; the land between this and the Juba mouth being probably of deltaic origin. This branch was explored in a boat for twenty miles. The dense forests formed a broad belt on both sides on the river, and after steaming for five days through uninhabited woods the *Kenia* suddenly emerged into open country on August 2. The people were of very mixed race, friendly and well supplied with all sorts of food. Hills began to appear, and the river grew shallower, until on August 10 the steamer moored to the bank opposite Bardera. Here the Sultan forbad a landing, and the people, who numbered about 1200, were hostile, but ultimately peace was arranged, and one of the subordinate sheiks accompanied the *Kenia* to the rapids, where the river sweeps between steep rocky hills 300 to 400 feet high. There are three channels in the rapids, but at the time of the visit none was navigable, and the natives reported a waterfall over a ledge of rock about four hours' march further up, in latitude 2°34′ N. The wreck of the *Guelph* was visited and examined, but the rapid falling of the water made it necessary to hasten back to the sea. The climate throughout was found agreeable, and there were few mosquitoes. The river does not overflow, so there are no malarial swamps along the banks.

BREATH FIGURES.[1]

FIFTY years back Prof. Karsten, of Berlin, placed a coin upon glass, and by electrifying it made a latent impression, which revealed itself when breathed upon. About the same time Mr. W. R. (now Sir W. R.) Grove made similar impressions with simple paper devices, and fixed them so as to be always visible. A discussion of Karsten's results occurs in several places, but I have not been able to find details of his method of performing the experiment. During my attempts to repeat it some effects have appeared which seem to be new and worthy of record.

After many trials I found the following method the most successful:—A glass plate, six inches square, is put on the table for insulation: in the middle lies a coin with a strip of tinfoil going from it to the edge of the glass: on this coin lies the glass to be impressed, four or five inches square, and above it a second coin. It is essential to polish the glass scrupulously clean and dry with a leather: the coins may be used just as they usually are, or chemically cleansed, it makes no difference. The tinfoil and the upper coin are connected to the poles of a Wimshurst machine which gives three or four inch sparks. The handle is turned for two minutes, during which one-inch sparks must be kept passing at the poles of the machine. On taking up the glass one can detect no change with the eye or the microscope; but when either side is breathed upon, a clear frosted picture appears of that side of the coin which had faced it: even a sculptor's mark beneath the head may be read. For convenience those parts where the breath seems to adhere will be called white, the other parts black. In this experiment the more projecting parts of the coin have a black counterpart, but there is a fine gradation of shade to correspond with the depth of cutting in the device: the soft undulations of the head and neck are delicately reproduced.

The microscope shows that moisture is really deposited over the whole surface, the size of the minute water granulation increasing as the point of the picture is darker in shade.

There seems to be no change produced by the use of coins of different metals.

If sparking is allowed across the glass instead of at the poles of the machine, traces of metal are sometimes deposited beyond the disk of the coin, but not within it.

[1] Paper read by Mr. W. B. Croft before the Physical Society of London on June 24, 1892.

Around the disk is a black ring quarter inch broad: sometimes the milling of the coin causes radial lines across this halo.

If carefully protected there appears to be no limit to the permanence of the figures, but commonly they are gradually obscured by the dust gathered up after being often breathed upon: some of the early ones, done more than two years back, are still clear and well defined in the detail.

It is possible to efface them with some difficulty by rubbing with a leather whilst the glass is moist. They are best preserved by laying several together when dry and wrapping them in paper: they are not blurred by this contact.

It is a curious fact that certain developments take place after a lapse of some weeks or months. The dark ring around the disk gradually changes into a series of three or four, black and white alternately; other instances of such a change will be noted below.

Let it be noticed that in coin pictures the object is near to, but not in contact with, the glass: for in the best specimens the rim of the coin keeps the inner part clear of the surface.

Obviously a small condenser is made by the coins: it is not essential; at the same time images made by a single coin, put to a single pole, are inferior.

The plan which gives the surest and most beautiful results is to place five or six coins, lying in contact side by side in a cross or star, on either side of the glass: it is not necessary that each coin should exactly face one on the other side.

There has not appeared any distinction between the figures made by positive and negative electricity.

When several coins are placed side by side, touching one another, there appear in the spaces between them, which are mostly black, well-defined white lines, common tangents to the circular edges of the coins. If these are of equal size the lines are straight; otherwise they are curved, concave towards a smaller coin. They seem to be traces in that plane of the loci of intersection of equipotential surfaces.

Similar effects are obtained when coins and glasses are piled up alternately, and the outer coins are put to the poles of the machine. With six glasses and seven coins perfect images have been formed on both sides of each glass. With eight glasses the figures were imperfect; but there is little doubt this could be improved by continued trials as to the amount of electricity applied.

If several glasses are superposed and coins are applied to the outer surfaces, there are only the two images at the outside. After the electrification there is a strong cohesion between the plates.

It requires some practice to manage the electrification so as to produce the best results. There are two forms of failure which present interesting features. Sometimes a picture comes out with the outlines dotted instead of being continuous. At other times, if the electrification is carried too far, the impression comes out wholly black; but on rubbing the glass when dry with a leather the excess is somehow removed. Naturally it is difficult to rub down exactly to the right point, but I have succeeded on several occasions in developing from a blank all the fine detail of elaborate coins.

Here, again, we have another instance of the development by lapse of time, for an over-excited piece of glass usually gives a clear picture after an interval of a day or two.

Impressions from stereotype plates have been taken of which the greater part is legible: the distinctness usually improves after a few days. In default of a second plate, a piece of tin-foil about the same size should be put on the opposite side of the glass.

Sheet and plate glass of various thicknesses have been used without any noticeable change either in the treatment or the results.

I have put an impressed glass on a photographic plate in the dark, but did not get any result on developing: my imperfect skill in photographic matters leaves this experiment inconclusive.

Probably all polished surfaces may be similarly affected: a plate of quartz gives the most perfect images, which retain their freshness longer than those on glass.

Mica and gelatine give poorer results: it is not possible to polish the surface to the necessary point without scratching it.

On metal surfaces fairly good impressions can be produced if, as Karsten advises, oiled paper is put between the coin and the surface.

In the order of original discovery the figures noticed by Peter Riess should come first. He discusses a breath-track made on

glass by a feeble electrical discharge; as well as two permanent marks, noticed by Ettrick, which betray a disintegration of the surface.

I have found that when a stronger discharge is employed more complex phenomena of a similar kind are produced. A six-inch Wimshurst machine is arranged with extra condensers, as if to pierce a piece of glass. If this is about four inches square the spark will generally go round it. For a day, more or less, there is only a bleared watery track, $\frac{3}{10}$ inch wide, when the glass is breathed upon; but after this time others develop themselves within the first, a fine central black line with two white and two black on either side, the total breadth being the original $\frac{3}{10}$ inch. These breath-lines do not precisely coincide in position with the permanent scars, but the central one is almost the same as a permanent mark, which the microscope shows to be the surface of glass fractured into small squares of considerable regularity: on either side is a grey-blue line always visible, which Riess ascribes to the separation of the potash. After several months I found two blue lines on either side, which I believe were not visible at first. Of course these blue lines may be seen on most Leyden jars, where they have discharged themselves across the glass.

In 1842 Möser, of Königsberg, produced figures on polished surfaces by placing bodies with unequal surfaces near to them; the action was ascribed to the power of light, and his results were compared with those of Daguerre. Möser says, "We cannot therefore doubt that light acts uniformly on all bodies, and that, moreover, all bodies will depict themselves on others, and it only depends on extraneous circumstances whether or not the images become visible." In general, the multitude of images would make confusion; it can only be freshly polished surfaces that are free to reveal single definite impressions. However great Möser's assumption may be, there are many achievements of modern photography that would be as surprising if they were not so familiar. I have not the means of knowing the precise form of Möser's methods: in the experiments which follow there is usually contact and light pressure, and if they are not wholly analogous, they may for that cause help to generalize the idea: in none of these is electricity applied.

A piece of mica is freshly split, and a coin lightly pressed for thirty seconds on the new surface: a breath-image of the coin is left behind. At the same time it may be noticed that the breath causes abundant iridescence over the surface, whilst it is in a fresh state. It is not clear how the electricity of cleavage can have an active agency in the result.

It is familiar to most people that a coin resting for a while on glass will give an outline of the disk, and sometimes faint traces of the inner detail when breathed upon.

An examination-paper, printed on one side, is put between two plates of glass and left for ten hours, either in the dark or the daylight: a small weight will keep the paper in continuous contact, but this is not necessary if thick glass is used. A perfect breath-impression of the print is made, not only on the glass which lay against the print, but also on that which faced the blank side of the paper. Of course the latter reads directly, and the former inversely; the print was about one year old, and presumably dry.

More often both impressions are white, sometimes one or other or both are black. At other times the same one may be part white and part black, and they even change while being examined.

During a sharp frost with east winds early in March, 1890, these impressions of all kinds were easy to produce, so as to be quite perfect to the last comma; but in general they are difficult, more especially those from the blank side.

At the best period those from the blank side of the paper were white and very strong; also there were white spots and blotches revealed by the breath. They seemed to correspond with slight variations in the structure of the paper, and suggest an idea that the thickness of the ink or paper makes a minute mechanical indentation on the molecules: the state of these is probably tender and sensitive under certain atmospheric conditions, as happens with steel in times of frost.

The following experiments easily succeed at any time:— Stars and crosses of paper are placed for a few hours beneath a plate of glass: clear white breath-figures of the device will appear. A piece of paper is folded several times each way to form small squares, then spread out and placed under glass: the raised lines of the folds produce white breath-traces, and a letter weight that was above leaves a latent mark of its circular rim.

Some writing is made on paper with ordinary ink and well dried: it will leave a very lasting white breath-image after a few hours' contact. If, with an ivory point, the writing is traced with slight pressure on glass, a black breath-image is made at once. Of course this reads directly, and the white one inversely. It is convenient to look through the glass from the other side for inverse impressions, so as to make them read direct.

Plates of glass lie for a few hours on a table-cover worked with sunflowers in silk: they acquire strong white figures from the silk.

In most cases I have warmed the glass, primarily for the sake of cleansing it from moisture; but I have often gone to a heat beyond what this needs, and think that the sensitiveness has been increased thereby.

It is not easy to imagine what leads to the distinction between black and white, different substances act variously in this respect. I have placed various threads for a few hours under a piece of glass, which lay on them with light pressure: wool gives black, silk white, cotton black, copper white. A twist of tinsel and wool gives a line dotted white and black; after a time these traces show signs of developing into multiple lines as in the spark figures.

Two cases have been reported to me where blinds with embossed letters have left a latent image on the window near which they lay; it was revealed in misty weather, and had not been removed by washing. I have not had a chance to see these for myself, but both my informants were accustomed to scientific observation.

A glass which has lain above a picture for some years, but is kept from contact by the mount, will often show on its inner side an outline of the picture, always visible without breath. It seems to be a dust figure easily removed: possibly heat and light have loosened fine paint particles, and these have been drawn up to the glass by the electricity made in rubbing the outer side to clean it. The picture must have been well framed and sealed from external influences; most commonly dust and damp get in and obscure such a delicate effect.

I am not able to suggest simple causes for these varied effects. I am not inclined to think, except in the case of water-colours, which is hardly part of the enquiry, that there is a definite material deposit or chemical change; one cannot suppose that imperceptible traces of grease, ineradicable as they may be, would produce complete and delicate outlines. The cleaning off of impressions may at first seem to indicate a deposit; but this renewal of the surface might rather be like smoothing out an indented tin-foil surface: such a view might explain the case where a blank over-electrified disk is developed into fine detail. The electrified figures seem to point to a bombardment, which produces a molecular change, the intensity of electricity bringing about quickly what may also be done by slow persistent action of mechanical pressure. At present it seems as if most of the phenomena cannot be drawn out from the unknown region of molecular agency.

While experimenting I was not within reach of references to former researches, but I have since done my best to find them out, and to indicate all I have learnt in the body of my paper.

Poggendorff, vol. lvii. p. 492; translated in *Archives de l'Electricité*, 1842, p. 647.
Riess' "Electrische Hauchfiguren" in "Repertorium der Physik"; translated in *Archives de l'Electricité*, 1842, p. 591.
Reiss' "Die Lehre von der Reibungs Electricität," vol. ii. pp. 221–224.
Mascart, "*Electricité Statique*," vol. ii. p. 177.
Taylor's "Scientific Memoirs," vol. iii.

SCIENTIFIC SERIALS.

American Journal of Science, December.—An experimental comparison of formulæ for total radiation between 15° C. and 110° C., by W. de Conte Stevens. The formulæ given by Dulong and Petit, by Rosetti, Stefan, and Weber, were tested for a comparatively small range of differences by a determination of the heat radiated from an iron disc at a distance of about 30 cm. from a thermopile. The results tended to show that H. F. Weber's formula (*Sitzungsber.*, Berlin, 1888) agrees most closely with experiment. Stefan's formula, according to which the heat emitted in unit of time is proportional to the fourth power of the absolute temperature, is also fairly accurate,

but Dulong and Petit's values are too high, and Rosetti's too low.—Notes on silver, by M. Carey Lea.—Notes on silver chlorides, by the same. Fused silver chloride poured into petroleum and placed in the sunlight without removing it from the liquid, is instantly darkened. From this it appears that the presence of oxygen or moisture is not essential to the darkening of silver chloride in light. The chlorine may be taken up by some other substance.—A remarkable fauna at the base of the Burlington Limestone in north-eastern Missouri, by Charles Rollin Keyes.—Glacial pot-holes in California, by H. W. Turner.—The lavas of Mount Ingalls, California, by H. W. Turner.—A method for the quantitative separation of barium from strontium by the action of amyl alcohol on the bromides, by Philip E. Browning. The solubility of barium bromide is about 0·0013 grm. on the oxide in 10 cc. of amyl alcohol, while that of strontium bromide is 0·2 grm. To obtain the bromides, the precipitated and thoroughly washed carbonates of Ba and Sr are treated with hydrobromic acid obtained by the action of dilute sulphuric acid on potassium bromide.—Note on the method for the quantitative separation of strontium from calcium by the action of amyl alcohol on the nitrates, by P. E. Browning. Recent work on this method has shown that the total correction amounts to 0·0006 grm. on the strontium oxide, and 0·0010 on the calcium as sulphate.—Study of the formation of the alloys of tin and iron, with descriptions of some new alloys, by W. P. Headden.—Notes on the Cambrian rocks of Pennsylvania and Maryland from the Susquehanna to the Potomac, by C. D. Walcott.—Volcanic rocks of South Mountain in Pennsylvania and Maryland, by G. H. Williams.

Wiedemann's Annalen der Physik und Chemie, No. 11.—On the behaviour of allotropic silver towards the electric current, by A. Oberbeck.—On the indices of refraction of dilute solutions, by W. Hallwachs.—On capillary constants, by M. Cantor.—On the chemistry of the accumulator, by M. Cantor.—On the fall of potential during discharges, by O. Lehmann. A series of important investigations on discharges between electrodes and in tubes without electrodes.—Expansion of water with the temperature, by K. Scheel.—A method for determining the density of saturated vapours and the expansion of liquids at higher temperatures, by B. Galitzine. This method has the advantage of extreme simplicity combined with accuracy. A small glass tube, about 5 cm. long and a few mm. thick, is closed at one end and drawn out into a capillary at the other. After determining the weight and internal volume of the tube, a small quantity of the substance to be investigated is introduced into it in the liquid state. This is made to boil, and then the tube is sealed by fusing. On raising the temperature, the surface of separation between the liquid and its vapour is displaced, until at a certain temperature all the liquid is converted into saturated vapour. The tube is then cooled until the vapour reappears, when the temperature is again taken. This can be repeated several times, thus giving an accurate value for the density of saturated vapour at a certain temperature. The same process can be used to determine the expansion of the liquid. As the temperature rises, the volume of the liquid will in general increase up to a certain point, when the vaporization becomes more pronounced. This maximum, which can be observed more accurately by drawing out the tube near that point, gives a value for the expansion. For the density at that point is a function of the density at 0° C. and the temperature, and the pressure is that of the saturated vapour at the same temperature. Thus it is only necessary to find the volumes of the liquid and the vapour, and the density of the latter from the previous experiment.—On radiant energy, by B. Galitzine.—Note on the electricity of waterfalls, by J. Elster and H. Geitel.—Apparatus for demonstrating the Wheatstone bridge arrangement, by A. Oberbeck.—Determination of the coefficient of self-induction by means of the electro-dynamometer, by O. Troje.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 15.—On some new reptiles from the Elgin Sandstone, by E. T. Newton, communicated by Sir Archibald Geikie, F.R.S.

During the last few years a number of reptilian remains have been obtained from the Elgin Sandstone at Cuttie's Hillock, near Elgin, which are now in the possession of the Elgin Museum and of the Geological Survey. These specimens represent at least eight distinct skeletons, seven of which undoubtedly belong to the Dicynodontia, and one is a singular horned reptile, new to science. All the remains yet found in this quarry are in the condition of hollow moulds, the bones themselves having entirely disappeared. In order, therefore, to render the specimens available for study, it was necessary, in the first place, so to display and preserve these cavities that casts might be taken which would reproduce the form of the original bones. Gutta-percha was found to be the most suitable material for taking these impressions; and in some instances, especially in the case of the skulls, the casts had to be made in several parts and afterwards joined together.

The first specimen described is named *Gordonia Traquairi*; it is the one noticed by Dr. Traquair in 1885, and referred to the Dicynodontia; besides the skull, it includes fragmentary portions of other parts of the skeleton, and is contained in a block of sandstone which has been split open so as to divide the skull almost vertically and longitudinally. The two halves have been so developed that casts made from them exhibit the left side and upper surface, as well as the main parts of the palate and lower jaw. In general appearance this skull resembles those of *Dicynodon* and *Oudenodon*. The nasal openings are double and directed laterally; the orbits are large and look somewhat forwards and upwards. The supra-temporal fossa is large, and bounded above by the prominent parieto-squamosal crest, and below by the wide supra-temporal bar, which extends downwards posteriorly to form the long pedicle for the articulation of the lower jaw. There is no lower temporal bar. The maxilla is directed downwards and forwards to end in a small tusk. Seen from above, the skull is narrow in the inter-orbital and nasal regions, but wide posteriorly across the temporal bars, although the brain-case itself is very narrow. There is a large pineal fossa in the middle of a spindle-shaped area, which area is formed by a pair of parietals posteriorly and a single intercalary bone anteriorly.

The palate is continuous with the base of the skull; the pterygoids on each side send off a distinct process to the quadrate region. Towards the front the mediam part of the united pterygoids arches upwards, and the outer sides descend, forming a deep groove; from the evidence of other specimens it is clear that the palatines, extending inwards, converted this groove into a tube, and thus formed the posterior nares. The ramus of the lower jar is deep, with a large lateral vacuity, and the two rami are completely united at the symphysis. The back of this skull is not seen, but two other specimens, referable to this same genus, show that the occiput had two post-temporal fossæ on each side.

This specimen is distinguished from *Dicynodon* by the presence of two post-temporal fossæ on each side of the occiput, by the small size of the maxillary tusk; and probably by the elongated spindle-shaped area enclosing the pineal fossa, and also by the slight ossification of the vertebral centra.

A second and much smaller specimen, provisionally referred to *G. Traquairi*, has, besides the skull, a fore-limb well preserved. The humerus of this shows the usual Anomodont expansion of its extremities; its large deltoid crest is angular, and set obliquely to the distal end.

Three other species are referred to the same genus, namely:—

Gordonia Huxleyana, which is distinguished from *G. Traquairi* by its proportionately wider and more depressed skull, and by the absence of the concavity between the orbits which is present in the latter species. The humerus has the distal extremity oblique to the deltoid crest, which was probably rounded and not angular.

G. Duffiana has the skull even wider than in *G. Huxleyana*, and the portion of a humerus found with this skeleton has the two extremities set nearly at right angles to each other.

G. Juddiana has an elongated skull resembling that of *G. Traquairi*, but the parietal crests are less developed, the bones of the nasal region are much thickened and overlap the nasal apertures, the small tusk is placed a little further back and points more directly downwards, and the pineal fossa is smaller than in either of the other species.

A second generic form is named *Geikia Elginesis*. This is a skull nearly allied to *Ptychognathus*, Owen, but is distinguished by its shorter muzzle and the entire absence of teeth; the upper part of the skull, between the orbits, is also peculiar, forming a deep valley open anteriorly, with a ridge on each side, the anterio

end of which forms a large prominence above and in front of the orbit. The occiput has only one (the lower) post-temporal fossa open on each side. The maxilla is produced into a tooth-like prominence, which occupies a similar position to the tusks of *Gordonia;* but the bone is too thin to have supported a tooth, and in all probability it was covered by a horny beak. The lower jaw has a strong symphysis, a distinct lateral vacuity, and the oral margin, at the foot of each ramus, bears a rugose prominence.

Elginia mirabilis is the name proposed for the skull of a reptile, which, on account of the extreme development of horns and spines, reminds one of the living lizards *Moloch* and *Phrynosoma.* The exterior of this skull is covered in by bony plates, the only apertures being the pair of nostrils, the orbits, and the pineal fossa. The surfaces of the bones are deeply pitted, as in crocodiles and labyrinthodonts. The horns and spines, which vary from $\frac{1}{4}$ in. to nearly 3 in. in length, are found upon nearly every bone of the exterior. The development of the epiotics, and the arrangement of the external bones, resemble more the Labyrinthodont than the reptilian type of structure; while the palate, on the other hand, conforms more nearly to the Lacertilian type, and, with the exception that the pterygoids are united in front of the pterygoid vacuity, agrees with the palate of *Iguana* and *Sphenodon.* There are four longitudinal ridges along the palate, some of which seem to have carried teeth. The oral margin was armed with a pleurodont dentition, there being on each side about twelve teeth with spatulate crowns, laterally compressed and serrated. With the exception of the smaller number of the teeth, we have here, on a large scale, a repetition of the dentition of *Iguana.* This peculiar skull seems to show affinities with both Labyrinthodonts and Lacertilians, and is unlike any living or fossil form; its nearest, though distant, ally apparently being the *Pareiasaurus* from the Karoo beds of South Africa.

Linnean Society, December 1.—Prof. Stewart, President, in the chair.—A letter was read from the Rev. Leonard Blomefield, expressing his high appreciation of the compliment paid him by the presentation of the illuminated address which had been signed by the Fellows present at the last meeting of the Society and forwarded to him.—Messrs. H. and J. Groves exhibited specimens of several Irish *Characeæ* collected during the past summer. *Nitella tenussima* from Westmeath and Galway had not been previously recorded from Ireland, and a large form of *N. gracilis* from two lakes in Wicklow had been only once previously met with. Referring to the former, Mr. H. Groves remarked that although it might be expected to occur in all the peat districts it had only been found in two widely separated localities in England, namely, in the Cambridgeshire Fens and in Anglesea.—Mr. A. Lister made some remarks on the nuclei of Mycetozoa, exhibiting some preparations under the microscope.—Mr. E. Cambridge Phillips forwarded for exhibition a hybrid between red and black grouse, which had been shot in August near Brecon.—Mr. J. E. Harting exhibited and made remarks on some coleopterous larvæ which had been vomited by a child at Tintern, and had been forwarded by the medical attendant, Dr. J. Taylor Brown, for identification. The precise species had not been determined, but was considered to be allied to *Blaps mortisaga.* Mr. Harting drew attention to the fact that cases of voiding coleopterous larvæ were mentioned by Kirby and Spence (7th ed. p. 71), and by the late Dr. Spencer Cobbold in his work on parasites (1879, p. 269).—Mr. D. Morris exhibited some tubers of *Calathia allonia*, eaten as potatoes in Trinidad, where it is known as Tapee Nambour. Apparently a corruption from the French *topinambour* (artichoke).—A communication was read from Mr. J. H. Hart, of the Botanic Gardens, Trinidad, on *Œcodoma cephalotes* and the fungi it cultivates.—Prof. F. Jeffry Bell contributed a short paper on a small collection of Crinoids from the Sahul Bank, North Australia, some of which were new, and Mr. Edgar Smith communicated descriptions of some new land shells from Borneo.—The meeting adjourned to December 15.

Physical Society, December 9.—Mr. Walter Baily, Vice-President, in the chair.—The Chairman announced that an extra meeting would be held on January 13, 1893.—Prof. S. P. Thompson's communication on Japanese magic mirrors was postponed.—Mr. W. B. Croft read a paper on the spectra of various orders of colours in Newton's scale. After referring to the definition of the *order* of colours by reference to the retardation in wave-lengths, produced by different thicknesses of selenite between crossed polarizer and analyzer, the author went on to say that several books on optics implied that the number of bands in the spectra of these colours was the same as the order of the colour. On obtaining selenites of the first four orders of red from Messrs. Steeg and Reuter, he found that the first three orders gave one dark band each, and that of the fourth order three dark bands. Further experiments showed that the thicknesses of the selenites were in the proper proportions required to give the first four orders of red. The numbers of bands, the author explained, depended on the numerical possibilities of wave-length within the visible spectrum—that is, whether a multiple of the wave-length of one visible wave can be another multiple of a different wave. For example, taking the visible spectrum as extending from A (0·000760) to H (0·000394) and the wave-length of the line E in the green as 0·000527, it was shown that the first order of red was due to extinction of green by a thickness of crystal proportional to $1 \times 0·000527$, and would give one band in the green. For the second order, the thickness of crystal was proportional to $2 \times 0·000527$, viz. 0·001054, and this number was no other integral multiple of any other wave-length between A and H; consequently there could only be one band. Similarly it was shown that the third order of red could only have one band or possibly produce a shortening of the spectrum. With the fourth order of red three bands were obtainable, for $4 \times 0·000527 = 3 \times 0·000703$ and $= 5 \times 0·000422$. Three bands were therefore possible near E, A, G, respectively. At the conclusion of his paper, Mr. Croft directed attention to a very simple form of diffraction apparatus, by which most of the ordinary diffraction phenomena could be well seen, and which also served for spectrum observations. Mr. H. Miers pointed out that in Lewis Wright's "Practical Optics" a chart showing the bands corresponding to the first four orders of red was given. So far as he was aware, the subject was not fully discussed in the book. In reply, Mr. Croft said he had noticed Mr. Wright's chart, but believed the text implied that the number of bands should be the same as the order of the colour. Tyndall made definite statements to that effect.—Dr. W. E. Sumpner read a paper on the diffusion of light. The influence of diffusion in increasing the illumination of rooms and open spaces, had not, in the author's opinion, been sufficiently appreciated. Being impressed with the great importance of the subject, he was led to make determinations of the co-efficients of reflection, absorption, and transmission of diffusing surfaces. To give precision to terms sometimes vaguely used, several definitions were proposed. *Reflecting power* was defined as the ratio of the amount of light reflected from a surface to the total amount of light incident upon it; *illumination* of a surface, as the amount of incident light per unit of surface; *unit quantity* of light as the flux of radiation across unit area of a sphere of unit radius at whose centre a unit light is placed; and *brightness* as the candle-power per unit area in the direction normal to the surface. Denoting these quantities by η, I, Q and B respectively, and assuming the cosine law of diffusion (*i.e.* the candle-power in any direction is proportional to the cosine of the angle between the direction and the normal to the surface) it was shown that $\pi B = \eta I$, and that the average illumination (I′) of the walls of a room is related to the illumination (I) due to the direct action of the lights as expressed by the formula $I' = \frac{I}{1 - \eta}$. If the reflecting power of the walls, &c., be 50 per cent., $\eta = \frac{1}{2}$, and $I' = 2I$, whilst if $\eta = 0·8$, a number approximately true for white surfaces, then $I' = 5I$. The illumination due to the walls may, therefore, be far more important than that due to the direct rays from the lights. When the surfaces consist of portions of different reflecting power, the average reflecting power may be found from the equation $\eta = \frac{\eta_1 A_1 + \eta_2 A_2 + \text{\&c.}}{A}$, A being the total surface, and A_1, A_2, &c., the areas of surfaces whose reflecting powers are η_1, η_2, &c., respectively. This law is shown to be quite accurate for spherical enclosures. In measuring reflecting power, the surface was attached to a large screen of black velvet placed perpendicular to a 3-metre photometer bench. Two lights were used, one a Methven 2-candle standard placed at the end of the bench remote from the reflecting surface, and the other, a glow lamp of about 20-candle power, was attached to a slider which also carried a Lummer-Brodhun photometer. The glow-lamp served to illuminate the reflecting surface, but the photometer was screened from its direct rays. The formulæ used in reducing the observations are worked out in the paper

and tables of results given. Absorbing power was determined by measuring the candle-power of a glow-lamp, first when uncovered, and then when surrounded by a cylinder of the substance under test. It was found to be of great importance to distinguish between apparent and real absorption, for reflection from the surfaces of the cylinders increases the internal illumination. The true absorption coefficient (α) is given by $\alpha = (1 - \eta)\frac{k_0 - k_1}{k_0}$, where η is the reflecting power and k_1 and k_0 the candle-powers with and without the envelope of material under test. In determining transmitting power, the Methven standard and photometer were placed on one side of the surface and the glow-lamp on the other. Difficulties were experienced from the fact that some materials such as tracing paper, transmit part of the light directly (like transparent substances), and another part by diffusions according to the cosine law. Methods for discriminating between the different parts were therefore devised both in the reflection and transmission experiments, and consistent results subsequently obtained. Tables and curves showing the close agreement of calculated and observed values, are included in the paper. An abstract of some of the tables of numbers is given below:—

Material.	Percentage reflecting power η.	Percentage absorption α.	Percentage Transmission τ.	$\eta + \alpha + \tau$
Blotting paper	82	13·8	9·2	105·0
Cartridge paper ...	80	12·2	11·2	103·4
Tracing cloth	35	15·0	54·4	104·4
Tracing paper	22	7·0	76·0	105·0
Ordi ary mirror... ...	82			
Ordinary foolscap ...	50 to 70			
Tissue paper (one thickness	40			
Tissue paper (two thicknesses	55			
Yellow wall-paper ...	40			
Blue paper	25			
Dark brown paper ...	13			
Yellow painted wall ...	20			
Black cloth	12			
Black velvet	0·4	(apparent)		
Arc lamp globes—				
Light opal	—	15		
Dense opal	—	39		
Ground glass ...	—	42		

Theoretically the sum of the reflecting, absorbing and transmitting powers should be unity, but from the above table it will be noticed that they exceed 100 per cent., by amounts greater than can be accounted for by experimental error. This discrepancy, the author thought, might be attributed to the law of cosines not being exactly fulfilled. Mr. A. P. Trotter said he had been interested in the subject of diffusion for many years with a view to obviating the glare of arc lamps. Some experiments he made on reflecting power gave unsatisfactory results, owing, as he now saw, to his not taking the solid angles subtended by the reflecting surfaces into account. The reflecting power of substances was of great importance in the illumination of rooms; in one case measured by Dr. Sumpner and himself, two-thirds of the total illumination was due to the walls. It would greatly simplify measurement of reflecting power if some substance could be adopted as a standard. Referring to the cosine law, he said he had found it true, except when the angles of incidence approached 90°. In cases where considerable total reflection took place the apparent brightness near the normal direction was greatly in excess of that in other directions. These points he illustrated by polar curves. He had also considered what should be the nature of a roughened or grooved surface to give the cosine law of diffusion. No simple geometrical form of corrugations, &c., seemed to fulfil the required conditions. Dr. Hoffert said the high numbers given for the reflecting powers of substances were very interesting. Most people had noticed the effect of laying a white table cloth in an ordinary room. He had also observed that wall papers of the same pattern, but slightly different in colour, had very different effects in producing increased illumination, and wished to know if the influence of small differences in colour and texture on diffusing power, had been investigated. Mr. Blakesley defended the cosine law, and suggested that the summation of the powers exceeding unity might be due to the fact that the enclosure reflected heat as well as light, thus raising the temperature and increasing the efficiency of the radiant. Mr. Addenbrooke said the importance of the subject was impressed on him when he passed through America three years ago and noticed the crude manner in which electric lighting was there carried out. If using good reflecting surfaces increased the illumination of a room 50 per cent., it was like reducing the cost of electricity from 8*d.* to 4*d.* per unit. He could hardly conceive any subject of more practical importance than the one before the meeting. Dr. C. V. Burton did not understand why the cosine law should be objected to, for it was possible that no surface was perfectly diffusive. The effect of reflection from walls, &c., say in illuminating a book would not, he thought, be so great as would appear from the numbers given, for one usually read near a light, and the reflected light falling on the book was only a small part of the whole, on account of the greater distances of the walls. Another member pointed out that in experiments such as those described, it was very important to screen the photometer and surfaces from all radiation other than that under test. He rather doubted whether any surface reflected as well as mirrors. White surfaces might appear to do so, but this was probably because the eye would overestimate it, owing to the superiority of white in aiding distinct vision. Dr. Sumpner in reply said he had, as stated in the paper, used white blotting paper as a standard of reflecting power and found it very convenient. His most careful measurements had been made on whitish surfaces and not on coloured ones. Where one colour, say red, preponderates in a room, the average light would be much redder than that emitted by the source owing to the other colours being absorbed. In considering illumination as related to distinct vision, it was necessary to take account of the eye itself, for the pupil contracted in strong lights and opened in feeble ones. This subject he hoped to treat fully in a subsequent paper.

Entomological Society, December 7.—Frederick DuCane Godman, F.R.S., President, in the chair.—The President announced the death, on December 2, of Mr. Henry T. Stainton, F.R.S., an ex-President and ex-Secretary of the Society.—Mr. Jenner Weir exhibited a species of Acræa from Sierra Leone, which Mr. Roland Trimen, F.R.S., who had examined the specimen, considered to be a remarkable variety of *Telchinia encedon*, Linn. It was a very close mimic of *Limnas alcippus*, the usual West African form of *Limnas chrysippus*. The upper wings of the specimen were rufous and the lower white, as in the model, and the resemblance in other respects was heightened by the almost total suppression of the black spots in the disc of the upper wings, characteristic of the usual markings of *T. encedon.*—Mr. F. J. Hanbury exhibited a remarkable variety of *Lycæna adonis*, caught in Kent this year, with only one large spot on the under side of each upper wing, and the spots on the lower wings entirely replaced by suffused white patches. He also exhibited two specimens of *Noctua xanthographa* of a remarkably pale brownish grey colour, approaching a dirty white, obtained in Essex, in 1891; and a variety of *Acronycta rumicis*, also taken in Essex, with a dark hind margin to the fore wings.—Mr. H. J. Elwes exhibited a living specimen of a species of *Conocephalus*, a genus of *Locustidæ*, several species of which, Mr. McLachlan stated, had been found alive in hothouses in this country.—Dr. T. A. Chapman exhibited immature specimens of *Tæniocampa gracilis*, *T. gothica*, *T. populeti*, *T. munda*, *T. instabilis* and *T. leucographa*, which had been taken out of their cocoons in the autumn, with the object of showing the then state of development of the imagos.—Mr. F. W. Frohawk exhibited a living specimen of the larva of *Carterocephalus palæmon* (*Hesperia paniscus*) hybernating on a species of grass which he believed to be *Bromus asper*. The Rev. Canon Fowler and Mr. H. Goss expressed their interest at seeing the larva of this local species, the imagos of which they had respectively collected in certain woods in Lincolnshire and Northamptonshire. Mr. Goss stated that the food-plants of the species were supposed to be *Plantago major* and *Cynosurus cristatus*, but that the larva might possibly feed on *Bromus asper.*—Mr. C. G. Barrett exhibited a long series of remarkable melanic varieties of *Boarmia repandata*, bred

by Mr. A. E. Hall from larvæ collected near Sheffield.—Mr. W. Farren exhibited four varieties of *Papilio machaon* from Wicken Fen; also a series of two or three species of *Nepticulæ* pinned on pith with the "minutien Nadeln," for the purpose of showing these pins.—Canon Fowler exhibited specimens of *Xyleborus perforans*, Woll., which had been devastating the sugar-canes in the West Indies.—Mr. E. B. Poulton, F.R.S., showed, by means of the oxy-hydrogen lantern, slides of various larvæ and pupæ, in illustration of his paper, read at the October meeting, entitled, "Further experiments upon the colour-relation between certain lepidopterous larvæ and their surroundings." He stated that he believed that nineteen out of twenty larvæ of *Geometridæ* possessed the power of colour adjustment. Mr. F. Merrifield, the Rev. J. Seymour St. John, and Mr. Jacoby took part in the discussion which ensued.—Mr. F. Merrifield read a paper entitled, "The effects of temperature on the colouring of *Pieris napi*, *Vanessa atalanta*, *Chrysophanus phlæas* and *Ephyra punctata*," and exhibited many specimens thus affected. Mr. Poulton, Dr. F. A. Dixey, Mr. Elwes, and Mr. Jenner-Weir took part in the discussion which ensued.—Mr. Kenneth J. Morton communicated a paper entitled, "Notes on *Hydroptilidæ* belonging to the European Fauna, with descriptions of new species."—Dr. T. A. Chapman read a paper entitled, "On some neglected points in the structure of the pupa of Heterocerous Lepidoptera, and their probable value in classification; with some associated observations on larval prolegs." Mr. Poulton, Mr. Tutt, Mr. Hampson, and Mr. Gahan took part in the discussion which ensued.—Mr. J. Cosmo-Melvill communicated a paper entitled, "Description of a new species of butterfly of the genus *Calinaga*, from Siam."—Mr. W. L. Distant communicated a paper entitled, "Descriptions of new genera and species of Neotropical *Rhynchota*."

PARIS.

Academy of Sciences, December 12.—M. d'Abbadie in the chair.—On certain asymptotic solutions of differential equations, by M. Emile Picard.—Description of a new electric furnace, by M. Henri Moissan. The furnace consists of two bricks of quicklime one upon the other, the lower one of which is provided with a longitudinal groove which carries the two electrodes, and between them is a small cavity serving as crucible, which contains a layer of several centimetres of the substance to be experimented upon. The latter may also be contained in a small carbon crucible. The highest temperature worked with was 3000° C., produced by a current of 450 amperes and 70 volts consuming 50 horse-power. In the neighbourhood of 2500°, lime, strontia and magnesia crystallized in a few minutes. At 3000° the quicklime composing the furnace began to run like water. At the same temperature the carbon rapidly reduced the oxide of calcium to the metallic state. The oxides of nickel, cobalt, manganese, and chromium were reduced in a few seconds at 2500°, and a button of uranium weighing 120 gr. was obtained from the oxide in ten minutes at 3000°.—Action of a high temperature on metallic oxides, by M. Henri Moissan. In all the experiments, the simple elevation of temperature produced the crystallization of all the metallic oxides experimented upon.—On the existence of the diamond in meteoric iron of the Cañon Diablo, by M. C. Friedel. A careful analysis has placed beyond doubt the existence of diamond in a portion of the Arizona meteorite presented to the Ecole des Mines. It occurs in small grains or a fine powder disseminated through the iron.—On the laws of expansion of fluids at constant volume; coefficients of pressure, by E. H. Amagat.—On the means of diminishing the pathogenic power of fermented beet-root pulp, by M. Arloing.—On the employment of free balloons for meteorological observations at very great heights, by M. Ch. Renard.—Photographic observations of Holmes's comet, by M. H. Deslandres.—On the locus of the mean distances of a point of an ordinary epicycloid, and of the successive centres of curvature which correspond to it, by M. G. Fouret.—On ordinary linear differential equations, by M. Jules Cels.—On the common cause of the evaporation and surface tension of liquids, by M. G. van der Mensbrugghe.—On the relation between the velocity of light and the size of the molecules of refracting liquids, by M. P. Joubin. From a comparison of a large number of substances the following law is deduced: The refraction is proportional to the square root of the quotient of the weight of the molecule by the number of constituent atoms (mean weight of the atom).—On the anomalous propagation of the light waves of Newton's rings, by M. Ch. Fabry.—On transparent diffusing globes, by M. Frédureau.—On a relation between molecular heat and the dielectric constant, by M. Runolfsson.—On the employment of guard-ring condensers and absolute electrometers, by M. P. Curie.—On the density of oxide of carbon and the atomic weight of carbon, by M. A. Leduc.—Critical reduction of Stas's fundamental determinations on potassium chlorate, by M. G. Hinrichs.—On a chloro-iodide of carbon, by M. A. Besson.—Action of anhydrous hydrofluoric acid on the alcohols, by M. Maurice Meslans.—Action of sulphuric acid on citrene, by MM. G. Bouchardat and J. Lafont.—Analysis of sulphate of quinine and quantitative determination of quinine in presence of the other cinchona alkaloids, by M. L. Barthe.—On the assimilation of the omasum to the abomasum of the Ruminants from the point of view of the formation of their mucous membrane, by M. J. A. Cordier.—On the differential osteological characters of rabbits and hares; comparison with leporides, by M. F. X. Lesbre.—Remarks on the preceding communication, by M. Milne-Edwards.—Myxosporidia of the bile-duct of fishes; new species, by M. P. Thélohan.—Method for ensuring the conservation of vitality in plants brought from distant tropical regions, by M. Maxime Cornu.—On the difference of transmissibility of pressures across ligneous, herbaceous, and succulent plants, by M. Gaston Bonnier.—On the structure of the *Gleicheniaceæ*, by M. Georges Poirault.—Salivary secretion and electric excitation, by M. N. Wedensky.—Action of the extract of cows' blood on animals affected with glanders, by M. A. Babes.—The blizzard of December 6 and 7, 1892, by M. Ch. V. Zenger.

BOOKS and SERIALS RECEIVED.

BOOKS.—The Elements of Graphic Statics: L. M. Hoskins (Macmillan).—Qualitative Analysis Tables and the Reactions of certain Organic Substances: Dr. E. A. Letts (Belfast, Mayne and Boyd).—Lord Rosse on the Gospel: Modernized by E. L. Garbett (W. Reeves).—An Atlas of Astronomy: Sir R. S. Ball (Philip).—Pioneers of Science: Prof. O. Lodge (Macmillan).—Collected Mathematical Papers of Prof. A. Cayley: Vol. V. (Camb. Univ. Press).—British Journal Photographic Almanac, 1893 (Greenwood).—A Manual of Bacteriology: Dr. G. M. Sternberg (New York, Wood).—La Terre Les Mers et Les Continents: F. Priem (Paris, J. B. Baillière).

SERIALS.—L'Anthropologie, Tom. 3, No. 5 (Paris, Masson).—Economic Journal, December (Macmillan and Co.).—Journal of the Chemical Society, December (Gurney and Jackson).

CONTENTS.

THURSDAY, DECEMBER 29, 1892.

GORE'S "VISIBLE UNIVERSE."

The Visible Universe. By J. Ellard Gore, F.R.A.S. (London: Crosby Lockwood and Son, 1893.)

THE object of this book is "not to propound any new hypothesis, but simply to explain and discuss theories which have been supported by well-known astronomers and other men of science" as to the "evolution of the Solar System," and to give a popular account of the "construction of the Universe *as we see it*, and its probable development from pre-existent matter."

Mr. Gore has already acquired considerable success as a popular writer on astronomical subjects, and the scheme of the present volume is, as we might expect, a very good one. The first three chapters are devoted to a popular account of the hypotheses of Kant and Laplace, the principal objections that have been urged against them, and the modifications and additions suggested by recent research. In subsequent chapters such subjects as the fuel of the sun, the luminiferous ether, the constitution of matter, celestial chemistry, and the meteoritic hypothesis are dealt with. Mr. Gore then reaches the purely descriptive portion of his subject, and gives excellent chapters on the Milky Way, and on "the latest results respecting the distribution of stars and nebulæ and their relative motions." Various theories of the construction of the Universe are then discussed, and in a final chapter the idea of infinite space and a finite universe is developed.

Although the general scheme of the book is excellent, the execution falls in many places far short of its promise and our expectations. When Mr. Gore confines himself to the historical and descriptive his work is, on the whole, well done, but in discussing theories he has in several cases obviously ventured out of his depth, and has consequently spoiled what would otherwise have been a valuable addition to popular astronomical literature.

For his chapters on the Nebular Hypothesis and Faye's theory of the formation of the solar system Mr. Gore has largely availed himself of M. Wolf's "Les Hypothèses Cosmogoniques." He has also introduced extensive quotations from "the late Mr. Jacob Ennis," but in considering Ennis as an authority, Mr. Gore is probably alone. Mr. Ennis was, on his own admission, not a mathematician, and certainly did not by "his own discoveries," place the nebular hypothesis on a firm mathematical basis. He proved Mars could not have satellites; that the heat of the sun was entirely due to chemical combination; that Sirius has twelve planetary attendants; and made several other equally important discoveries. *His* mathematical demonstration of the truth of the nebular hypothesis is about as sound as the well-known proofs that the earth's surface is flat. Mr. Gore would have done well to have omitted the quotations from Ennis, and to have filled the space with a fuller account of the recent mathematical investigations of the nebular hypothesis, especially those of Prof. G. H. Darwin.

Quoting freely from Young and Sir William Thomson, Mr. Gore is fairly safe in his chapter on the fuel of the sun, but he is in error in stating that "the meteoric theory of the sun's heat must be abandoned." It is true that the larger portion of the solar heat is believed to be due to shrinkage, but it is generally conceded that a considerable fraction has its origin in falls of meteoric matter into the sun. A glaring case of the misuse of a scientific term occurs in this chapter (p. 52), where Mr. Gore is responsible for the statement that "the theory generally held by astronomers ascribes the heat of the sun to shrinkage of its *mass* caused by gravitation." Mr. Gore surely meant volume.

The chapter on celestial chemistry is meagre and unsatisfactory. It seems incredible that the application of photography to spectroscopic work is not even mentioned, and that no allusion is made to the Draper catalogue of photographic stellar spectra, to Rowland's photographic map of the solar spectrum, or to any of the recent photographic work. Mr. Gore is also in error in this chapter when he states (p. 79) that although the great nebula in Andromeda "has never been resolved into stars the evidence of the spectroscope shows it is not gaseous." Bright bands have been seen in the spectrum by Backhouse Fowler, and myself, and these have been identified as probably due to carbon radiation.

The Meteoritic Hypothesis is dealt with in considerable detail, and here Mr. Gore is most seriously in error. He gives what is professedly "a review of the principal facts and arguments advanced by Lockyer," and carefully enumerates all the objections that have been urged by "his opponents," ending the account with the opinion that "on the whole, therefore, we seem bound to conclude that the weight of evidence is against the truth of the Meteoritic Hypothesis." The chapter bears internal evidence that Mr. Gore began his consideration of this hypothesis with the opinion which he enunciates as his final judgment, already formed.

The summary of Prof. Lockyer's book has not been made with the care that should have been bestowed upon it. There are at least two misquotations; on p. 91, the substitution of "periastron" for "perihelion" makes nonsense of what is otherwise an important paragraph, and on p. 113 the omission of the word "other" considerably modifies the meaning of the passage quoted.

There are several errors due to hasty compilation, observations and theories being attributed to Prof. Lockyer in cases where he only quotes the observations and adopts the theories. On p. 92 Mr Gore says "he (Lockyer) also finds line absorption in Comet Wells and the great September comet of 1882." This is misleading, the observations of absorption having been made by Copeland, Maunder, and Vogel. On p. 93 we find the "theory that the light of comets is due to collisions between the component meteorites" attributed to Prof. Lockyer. The theory is due to Reichenbach, Tait, and Sir William Thomson; Prof. Lockyer's contribution being the demonstration that spectroscopic observations lead to and support the hypothesis. The results of Tait's calculations given on pp. 227–229 of the "Meteoritic Hypothesis" are also attributed to Lockyer on p. 93 of Mr. Gore's book. On p. 95 we read, "the spectra of the true nebulæ consist of a very faint continuous spectrum crossed by one, two, three, or four bright lines" Lockyer gives seventeen bright lines in his table. Mr. Gore's footnote that "the complete hydrogen series of lines were

photographed by Dr. Huggins in 1890," in the great nebula in Orion is also a mistake.

Mr. Gore has evidently failed to appreciate the importance of several portions of Prof. Lockyer's book, and has consequently omitted to mention them in his summary. Thus the observations of meteoritic glows recorded on pp. 49-51 of the "Meteoritic Hypothesis" are entirely passed over. In these experiments it was found that on slowly warming meteorites in a vacuum tube through which electric discharges were passing, the spectrum of hydrogen was first developed, then carbon was added, and the first line due to any metal was the 500 line which is the characteristic nebular line. Further heating gave the 495 line and then the B magnesium lines. These experiments, omitted in Mr. Gore's summary, are an effective answer to the objections of Messrs. Liveing and Dewar given on p. 116 of this book, for we have here the 500 line developed in presence of hydrogen, and at a lower temperature than the B lines.

Mr. Gore believes that "one of the crucial tests of the meteoritic hypothesis" is the question of the identity of the 500 nebular line with the magnesium fluting at this wave-length. He says (p. 86) that "it is on the identity of this fluting (or rather its brightest edge) with the chief line in the spectrum of the nebulæ that the meteoritic hypothesis mainly depends," and from pp. 118-121 it is obvious that he thinks the evidence conclusively against the hypothesis on this point.

In the first case the identity of the 500 nebular line with magnesium is not essential to the meteoritic hypothesis, although the latest observations have strongly supported the case for the identity. The main point is whether the 500 nebular line is due to high or to low temperature, and whether nebulæ are high or low temperature phenomena. Previous to the publication of Prof. Lockyer's book all cosmical bodies were believed to be cooling. The nebulæ were considered to be the hottest of all bodies, and on losing heat were supposed to pass into stars of the Sirian type. Further loss of heat converted them into stars of the solar type, and by still further loss they became red stars with banded spectra before reaching final extinction. This hypothesis was supplemented by Dr. Croll, who suggested that nebulæ were formed by the complete and almost instantaneous volatilisation of these dark bodies on collision, the heat generated by impact being sufficient for the purpose. Lockyer's hypothesis supposes nebulæ to be loose swarms of colliding meteorites. Condensation of these swarms by gravitation increases the number of collisions, and as the temperature rises we get *stars* with bright lines in their spectra. Further increase of temperature gives red stars of Secchi's III. class, which pass with still rising temperature into stars with fine absorption lines in their spectra, and so on until the Sirian type is reached, in which we have the highest temperature. Collisions have now ceased and the process of cooling begins, the stars passing into the solar type, then into red stars of Secchi's IV. class, and to final extinction.

The lines in the spectra of nebulæ and bright line stars according to this theory may be due to three causes. (*a*) Radiating vapours filling the interspaces between the meteorites; the lines of hydrogen and the bands of carbon being due to these. (*b*) *Low temperature* lines of metals, due to grazing collisions of meteorites. (*c*) High temperature lines of metals, due to direct collisions. It is essential to the theory that low temperature lines o metals should be found in nebulæ spectra, and the low temperature origin of the 500 line seems clearly established. Its chemical origin is of quite secondary importance. That it is due to low temperature is shown by the experiments on meteoritic glows which Mr. Gore omits; by its presence in comets away from the sun, as observed by Huggins in 1866 and 1867 (this being the only line present), by Vogel in Coggia's comet, and Konkoly in the great September comet of 1882; and also by the fact that it persists in all temporary stars as the temperature falls and is the last line to disappear. Until these facts are explained away the foundation of the meteoritic hypothesis remains unshaken. Mr. Gore seems unaware that this main point is now generally admitted, for although the low temperature origin of nebulæ was denied by Dr. Huggins as late as 1889, it was adopted in his Address to the British Association at Cardiff in 1892.

There is early evidence in the book that Mr. Gore has entirely failed to grasp this essential point of the hypothesis. On p. 41, discussing Croll's impact theory of the formation of nebulæ, he says, "according to Prof. Lockyer the temperature of the original solar nebula was as high as that of the sun at present." Mr. Gore would have done well to have noted that on p. 528 of his book Prof. Lockyer explicitly states that "the temperature of the most prominent radiating vapours in nebulæ is about that of the Bunsen burner."

Mr. Gore's misconception of the theory and the spirit in which he approached its discussion are also shown on p. 101, where he says, "All these conclusions rest, of course, on the supposed coincidence of certain lines in the spectra of comets, nebulæ, and stars, with bright lines and flutings, a coincidence which has been disputed by other observers. Relying, however, on the accuracy of his experiments, Lockyer proposes a new grouping of cosmical bodies. He supposes some of these bodies to be increasing in temperature, while others—like our own sun—are cooling." To this he adds a footnote, "Lockyer's curve rests on this assumption, but it should be stated that some astronomers doubt that the sun is really cooling." We should be glad to know who these "astronomers" are. Mr. Gore himself is evidently not of their number, for he distinctly recognizes the sun as a cooling body in his chapter on the fuel of the sun, and specially mentions it as such on pp. 42 and 53. It is possible that Mr. Gore has misunderstood the apparently paradoxical fact that a body, in changing from a gas to a liquid, may rise in temperature while losing heat, but that will not justify the loose style which leaves it to be understood by the general reader that Lockyer's curve rests solely on his experiments, and the "assumption" that the sun is cooling, and that this fact is doubted by some astronomers. We are quite aware that Mr. Gore's expression will bear other interpretations, but this is the idea conveyed to several readers to whom we have shown the book.

Returning to the question of the coincidence of the 500 nebular line with magnesium, the evidence recorded by Mr. Gore is in favour of, rather than against, the identity.

His facts are:—Huggins finds the wave-length in the Orion nebula as 5004·75, the magnesium fluting being 5006·5, a difference of 1·75. At the same time, Huggins finds very little, if any, sensible motion in the line of sight. Mr. Keeler finds as a mean from 10 nebulæ 5005·68, magnesium being, according to his measurement, 5006·36, a difference of ·68. These latter observations completely invalidate Huggins's evidence on this point, especially as Mr. Keeler recognizes a motion of recession for the Orion nebula of 10·7 miles per second.

Mr. Gore ought to have recorded the fact that in Keeler's observations the comparisons for different nebulæ gave the magnesium sometimes more refrangible and sometimes less refrangible than the nebular line. Later observations of Keeler, "corrected for the earth's orbital motion and the sun's motion," give the nebular line a wave-length of 5005·93, *i.e.* only ·43 from the magnesium. Assuming Keeler's latest results as perfectly correct, and placing his position at Charing Cross, while representing the position found for this line by Dr. Huggins in 1868 at St. Paul's Cathedral, we find Dr. Huggins's limiting positions in 1889 as the extreme east and extreme west ends of Green Park, his 1890 position in the middle of Green Park, while the magnesium fluting will be at Cecil Street. When we consider that a motion in the line of sight of less than twenty miles per second will make the nebular line and the magnesium fluting absolutely coincident, that the rate of the sun's motion in space is estimated but not absolutely known, that these measurements are probably the most difficult of all astronomical observations, and that every increase of power and accuracy has brought the lines closer together, we are certainly ***not*** justified in stating that the "weight of evidence" is "against the truth of the hypothesis." The differences in recorded wave-lengths of well-known solar lines by experienced observers are in many cases greater than the difference in question here.

Mr. Gore regards the dispersion used by Prof. Lockyer as insufficient, and yet he records that sixteen prisms were used by Lockyer in some of his observations of the coincidence of the nebular line with magnesium, so that his dispersion was actually greater than that used by Dr. Huggins, and two-thirds that of Mr. Keeler, whose dispersion equalled twenty-four prisms.

The objections to that portion of the meteoritic hypothesis which deals with the meteoritic origin of the lines in the auroral spectrum do not in any way affect the main hypothesis. That this subject is unimportant is distinctly recognized by Prof. Lockyer, "Meteoritic Hypothesis," p. 97, where he claims that "certainly the coincidence is such as to justify us in regarding meteoritic dust as the origin of the spectrum *until a better and more probable origin is demonstrated.*"

We are told (p. 122) that Mr. Monck objects to Lockyer's hypothesis, because it contains no explanation of "why all the planets and asteroids and the great majority of the satellites revolve in the same direction, why the orbits of the larger bodies of the system deviate so little from the circle and why they are so nearly in the same plane." This was asked in 1890; and yet Prof. G. H. Darwin had in 1888 shown that a swarm of meteorites which, on the meteoritic hypothesis would form a nebula, may be considered as a gas, and therefore any answer that the nebular hypothesis can give to these questions will also apply to the meteoritic hypothesis.

Such puerile suggestions as that the meteorites used by Prof. Lockyer "*may have been*" of terrestrial origin: "that meteor clouds dense enough to produce the requisite amount of light by their collisions would also be dense enough to intercept *a great part of it* again on its way to the earth" (the italics are ours); and objections based on Mr. Monck's interpretation of Prof. Newton's calculations, and on opinions to which Mr. Monck "*inclines*" as to the origin of certain comets, are evidence that Mr. Gore has not hesitated to avail himself of anything that in any way seems to disagree with the meteoritic hypothesis. The whole of the "objections" of the "opponents" of Prof. Lockyer recorded by Mr. Gore are on matters of secondary importance, and have been insisted upon by him owing to his complete misconception of the theory. As a guide to the meteoritic hypothesis his chapter is misleading, and utterly valueless either as exposition or as criticism.

After his account of the meteoritic hypothesis Mr. Gore abruptly turns to a comparison of the various drawings that have been made of the Milky Way, and gives an interesting and valuable summary of the present state of our knowledge as to star distribution and movement and the construction of the Universe. For this portion of the book we have nothing but praise. It is carefully written and copiously illustrated. Mr. Gore has evidently taken the word "visible" in its widest possible sense, for he includes not only things visible to the retina of the eye, but those visible to the retina of the camera; and six excellent reproductions of photographs of nebulæ and stars clearly demonstrate the superiority of the latter for astronomical purposes. It is probable that the use of photography in the preparation of complete charts of the Milky Way will throw much new light upon many of the points discussed in this portion of the book, and may profoundly modify many of the views at present held; but in presenting a clear and concise account of the present state of our knowledge Mr. Gore has made a valuable addition to the literature of the subject. An appendix, in which are given various calculations and tables involved in the discussion of several points raised in the book, and a useful index, complete the volume.

A. Taylor.

THE IRON MANUFACTURE IN AMERICA.

On the American Iron Trade and its Progress during Sixteen Years. By Sir Lowthian Bell, F.R.S. (Edinburgh and London: Ballantyne, Hanson, and Co.)

It is impossible, in the limited space at our disposal, adequately to review this remarkable book, in which no branch of a very comprehensive subject appears to have escaped the author's close attention.

So full of detail and so exhaustive of the subject-matter are the various sections into which the work is divided, that we can do little more than glance at the numerous subdivisions.

The first section, dealing with international trade, dis-

cusses at length the American policy of protection. Comparison is made of American exports as affected by British free trade. Then follows a series of short articles on various subjects—the Anglo-American, imports of tinplates from this country, imports and exports of both countries, America as consumer and as exporter, and other important matters. By way of illustration copious tables are adduced with the author's deductions therefrom, and these will well reward the closest attention.

Section 2 deals with the relative cost of the necessaries of life in various mining and metallurgical localities :—

"In the United States the manufacturers are enriched at the expense of the agriculturist and of other consumers. Some time before the abolition of protective duties in the United Kingdom years of scanty harvests entailed a great amount of misery among the labouring population of these islands, and at all times the landed interest by the protection granted to it by law, imposed a burthen upon industry generally. This relation between land and industry is now, as we have seen, reversed in the United States, by which, according to our views, the manufacturers are enriched at the expense of the agriculturists and of other consumers.

"Circumstances have greatly changed since the repeal of the corn laws, and the general introduction of free trade in the British Isles, for we have a people, the largest food importers in the world, obtaining their supplies 3000 miles from where they are grown, frequently at prices as favourable as those charged in the cities of America itself."

Sir Lowthian Bell appears to grasp fully a difficult situation, and gives a fair summary of the relative economic position of the two countries, and though his views will hardly be endorsed in their entirety by Americans, the present statement of them cannot fail to strengthen the movement now in progress towards a modification of the existing fiscal policy.

It is somewhat out of our province here to comment upon the protective policy so ardently advocated in America, but we are of opinion that had iron manufacturers in the States adopted, even partially, our policy of free competition, they and their *employés* would now have been in a stronger position, and would have had a better prospect of successfully competing with us. It is possible that the very natural desire to foster the home industry has carried them a little too far.

In the next section the assemblage of materials on American is compared with that on British railways in an exhaustive manner.

Section 5 treats of the iron ores of the States, and is fully illustrated with maps, topographic and geological, together with the coal fields. The quantities raised at different periods are given, and show that in ten years the production of ore has been fully doubled. This is followed by a detailed account of the mines and costs of working. Pages 96–104 contain some interesting speculative matter on the genesis of iron ores; the cost of raising ore, together with chemical analyses, is compared with that of Great Britain and other countries. The importance of having iron free from phosphorus is shown. It is noted that iron ore suitable for the Bessemer acid process has been imported. In 1880 only 27·35 per cent. of native ore was deemed suitable and raised for this purpose.

Treating of raw material in the States, the writer gives a vivid picture of the boundless wealth of both ore and fuel existing within a limited area. In the great Lake district there is a wide strip of country over 1000 miles long, where ore is found, and this is insignificant when compared with the immense resources of fuel. The origin of natural gas, petroleum, and its uses receive attention —"natural gas is not a suitable form of fuel for the blast furnace."

Section 9, on the manufacture of coke, is interesting. At the outset coke is defined and compared with its analogues—anthracite or native coke. The losses necessarily entailed in the manufacture of coke are discussed, together with modes of minimizing them. It is shown that it is impossible to utilise the gases evolved in coking or heating coal in the blast furnace, and how slowly this was realized in early practice.

Here the author's ripe experience comes into play. The *rationale* of coking is tersely put, together with the methods dealing with the utilization and recovery of the ammonia, tar, &c., the products of the destructive distillation of coal, "or coking," with special appliances adapted for this purpose. The comparative merits of hard and soft coke in the blast furnace are discussed. Commercial details are appended, which speak for themselves, and which appear accurate.

From the section on the manufacture of pig iron it may be gathered that the gigantic methods of procedure, and the enormous energy diplayed in the business of the American iron manufacture, leave the average cautious Englishman in the rear. There is, however, the reverse side for consideration : it is questionable whether even the magnificent results before us have not been purchased at too great a cost. Enormous quantities of iron have without doubt been turned out, such as would never have been dreamt of here ; but it would seem that authorities are not yet in agreement as to the relative merit of English and American practice. So far our American cousins appear satisfied, pointing triumphantly to the saving of both time and material accruing from their present practice. At the Edgar Thompson Works (page 170) one of the furnaces ran 2462 tons of iron in one week, and showed an average make of 2813 tons per week with an expenditure of only 16·80 cwts. of coke per ton of iron. One needs, however, only to take Sir L. Bell's elaborate demonstration of the laws which govern the consumption of fuel in the blast furnace, and its utilization for the reduction of the ore, to see clearly that the above production is scarcely in the domain of practical work, carried out under ordinary conditions with average ores and fuel. Also (p. 162) he remarks, if Great Britain fails to offer striking examples such as are described by Mr. Potter and Mr. Gayley, yet, all things considered, a more uniform as well as loftier pitch of excellence in British furnace work can be proved.

Our space does not admit of a complete statement of Sir L. Bell's proofs ; shortly, he first tabulates the work done at Middlesbrough with that of the Pittsburg blast furnace, and absolutely demonstrates that the large makes are not altogether due to superior practice. A perusal of the tabular statement given satisfactorily accounts for the larger consumption of fuel in the English furnace.

The poorer ore of Cleveland consumes 3·48 cwt. of coke, as against only 1·42 cwt. in the richer ore used at Pittsburg for the future of the slag.

The quantity of slag determines the fuel required for its consumption, and here is the chief difference in the amount of fuel required, amounting to 2·06 cwts. The Clarence furnace consumed 19·99 cwt. of coke per ton of iron; the Pittsburg furnace consumed 16·80, difference 3·19, and deducting 2·06 from 19·99 cwt. = 17·93, showing an excess of 1·13 against the English furnace. This is practically the only margin we have for economy in the other sources of waste tabulated in Sir L. Bell's comparison of heat distribution.

A positive saving is effected of only 1·13 cwt., and reasons are given showing that, all things considered, this may be counterbalanced by the increased expenses incurred in American practice. As instance pp. 172–174 there are now four furnaces in action at the Clarence works performing duty well after 17½ years' service, as against the hard-driven furnaces in America with lining worn out, and useless in one-sixth of the period.

The limitation is well-defined in the following words, pp. 182–183:—

"As one who has been fifty years at blast furnaces, I am greatly impressed with the pitch of excellence to which the Americans have brought this useful invention.

"While saying so much I have not in my mind the enormous makes.

"In respect to this we must remember that neither in materials nor in labour can we look for any economy in this country.

"On the subject of large makes I must admit that I failed to shake the belief of my friend, Mr. E. C. Patter, that there is a great advantage in tasking the endurance of the furnace to the extent of reducing it to a wreck about every three years.

"I cannot say I am quite a convert to his creed, but recent experience, and the unswerving conviction of my American friends, have raised in my mind the disposition to make a trial of Cleveland ironstone, on what I have thought a questionable mode of action."

The question of heat intensity, or actual temperature, which must vary with the rate at which the fuel or coke is consumed, has not been mooted, and we admit there is no positive reason why it should.

Yet it is evident that a certain fuel—coke, for instance—may be so burnt as only to give a heat intensity barely sufficing for the fusion of lead. On the other hand, it may be so manipulated, *i.e.* rapidly consumed by a quick draught or forced blast "as to attain a heat intensity (temperature) sufficing for the fusion of pig iron."

Working with high pressure blast and driving in a large volume of air (87·15 cwts. Clarence, as against 71·20 cwts. Pittsburg, see p. 172), the heat intensity must be greater in the latter instance, and must, "according to the law of heat exchanges," result in the more rapid economic fusion of iron in the hearth, also intensifying the usual chemical reactions. This seems worth consideration; temperature is an important factor—in saying this it must not be inferred that the estimation of the calorics which a given fuel evolves, and their distribution, must be set aside; on the contrary, they remain the fundamental basis of any study bearing on the economic uses of fuel. Finally, one gathers on the whole that American practice is not universally superior to ours, and competent authorities are as a rule inclined to a compromise. In other words we might graft or partially adapt their practice to ours, so reaping the benefits of both; for something may be urged in favour of either system.

JOHN PARRY.

A COUNTY FAUNA.

The Fauna and Flora of Gloucestershire. By Charles A. Witchell and W. Bishop Strugnell. (Stroud: James, 1892.)

IT would really be almost difficult to discuss this book [illegible]ous spirit were it not that the publication of so ambitious a work as the Natural History of a County must always be regarded as a serious undertaking. The reader who has struggled through the volume will lay it down with a sigh—not of regret at leaving it, but at the thought that time has been wasted in its compilation.

A glance at the index is almost enough to condemn the book, without making any attempt at further acquaintance. Among nearly a score of errors in spelling, *subuteo*, *oesalon*, *tinninculus*, occur as three consecutive words. Nor is this carelessness by any means confined to the index. Such blemishes disfigure the book from beginning to end; and when, among a host of errors, we find such mistakes as *haliotidæ* and *helliborus*, we can hardly ascribe all the blame to the printer. The compilers usually give us "Cotteswold," but in the introduction the name is spelt "Cotswold," and there are pages on which both forms occur—in one case only a line apart.

A more serious fault is the want of balance in the work. The space allotted to birds occupies eighty-two pages, while the chapter on ants takes up nearly twenty, and that on wasps and bees close upon fifty pages. We may say at once that the two latter are so good, and stand out in such marked contrast to the rest of the work that, in spite of their disproportionate length, we hardly grudge a line of the room they occupy. Perhaps, however, it is the length of these papers which makes one of the writers on mosses omit "many other interesting species," for want of space. Another contributor calls his list of fungi "short and very imperfect." If the list is as complete as it is possible to make it, no one can fairly complain of its shortness; but surely it is scarcely worth while to print an avowedly imperfect list in what professes to be a County Flora.

The fauna opens with a brief account of the bats, a mere list of names, among which we look in vain for any evidence of observation. The notices of the quadrupeds contain some interesting particulars, but they present little that is new. In the article on the badger a good deal of information is given on the authority of a gentleman who appears to think no observations but his own are worthy of credence. One of his own observations is thus worded: "Any one who has caught badgers at night knows only too well that it is certain death to a dog

which is good enough to hold it in the open to follow it into an open drain large enough for the dog to reach it." Other people who have hunted badgers have found that an extremely small terrier is quite able to turn a badger from its earth; and that although the dog may be hurt, even seriously, by its formidable antagonist, the contest does not by any means mean "certain death" to it.

The chapter on birds bears evidence of having been put together in the most casual manner. Various contributors have sent in notes as to whether, in their experience, birds were rare or not, and these appear to have been printed without any attempt at summarizing. The result is that the whinchat is described in one line as "common," and in the next as "occasionally seen." The marsh-tit is "rare," and also "generally distributed." The cirl bunting is in one line called "rare" and "by no means rare." The coot is "rare" (!) and "frequently met with." The woodcock, according to one observer, "has been seen." If it were clear that such remarks applied to different parts of the county, there might be some sense in printing them. As they stand, they are useless and bewildering. One contributor is surprised at the occurrence of the gannet just outside the limits of the county, because "they generally inhabit the Bass Rock"! They certainly do, and "there's milestones on the Dover road." But perhaps there is nothing in the whole chapter which quite comes up to what we read about two starlings that one of the contributors watched "fighting furiously . . . each bird . . . trying to force its bill into that of the other. *He was informed that the purpose of each bird was by this means to render the opponent insensible; so as to be more easily destroyed.*"

In the article on reptiles occur these remarkable words:—"The slowworm is habitually 'slow,' but we know of no reptile or quadruped which, in proportion to its size, can move more rapidly."

There are several errors in spelling in the list of land and fresh-water shells, and it is rather misleading to give "Downs, under stones," for the habitat of the species here called *Bacutus*, without adding "near the sea."

Helianthemum polifolium is given as a Gloucestershire plant. It would be interesting to know if this is correct. The localities usually given are in Somerset and Devon.

Among the illustrations are some interesting figures of famous trees; but it seems hardly worth while to have inserted such a very ordinary-looking plate as that of the common crayfish.

Allusion has already been made to two chapters the excellence of which is all the more marked by contrast with the grandiloquent flights and the trivial details of much of this unfortunate volume. Rev. W. F. White's paper on ants contains, as might be expected, accounts of many interesting and original observations. Mr. Vincent Perkins's excellent chapter on wasps and bees, again, is extremely good, though the writer deals only with the neighbourhood of Wotton-under-Edge. That so imperfect, and, as far as much of its contents goes, we are afraid we must say untrustworthy, a book should ever have been published is matter for regret. The real "Fauna and Flora of the County of Gloucester" yet remains to be written.

OUR BOOK SHELF.

The Chemistry of Life and Health. "University Extension Manuals." By C. W. Kimmins, M.A., D.Sc., Staff Lecturer in Chemistry, Cambridge University Extension Scheme. (London: Methuen and Co., 1892.)

THIS little book is well adapted to secure the aim of the author, which is "to give sufficient information on the particular portions of the sciences involved to enable readers . . . . to appreciate fully the fundamental principles of hygiene." There can be no doubt of the importance, one might truly say, the national importance, of the spread of sound knowledge regarding the laws of health Such sound knowledge cannot be attained except it be built upon a well-laid foundation of chemistry and physiology. To lay the foundation, and rear the structure, in a little book of 160 pages is almost impossible. Dr. Kimmins has, wisely, omitted much; but what he retains is of fundamental importance; his facts are clearly enunciated and systematically arranged. A careful study of this book, especially when it is supplemented, as it is meant to be, by a course of lectures, cannot fail to be most useful. The book is written for ordinary people, not for professional students; the teaching is sound and clear. The first chapter, on the principles of chemistry, is the least satisfactory in the book; but in this chapter the author has attempted, what is surely unattainable, to give an elementary knowledge of the features of chemical action, the use of chemical symbols, and the molecular and atomic theory, in sixteen small pages. As an introduction to the study of the application of chemical facts and principles to the conditions of healthy life, the book is to be thoroughly recommended.

Naked-Eye Botany, with Illustrations and Floral Problems. By F. E. Kitchener, M.A. Pp. 182 and fifty-two woodcuts in the text. (London: Percival and Co., 1892.)

ON turning over the pages of this book one wonders why "Naked-Eye Botany" was chosen for the title, because, although a small book, it has some reference at least to a great many things that cannot be seen with the naked eye. It is something in the way of Prof. D. Oliver's "Lessons in Elementary Botany," but one misses the Professor in it. On p. 7 we are introduced to stomata, and physiological processes are described in some detail. Nevertheless it contains much useful matter, and with a little revision and better selections would make a very good first book. For example, the chickweed is chosen for the first lesson. But the flowers of this plant are so small and the number of parts in the various floral whorls is so variable that it is not a good subject to begin with. The "problems," or questions, also at the end of each chapter are too wide-reaching. Referring to *Aspidium Filix-mas*, we are told that the "production of the fertilized seed, more correctly called oosphere, from the prothallus, can scarcely be made out with the naked eye." Saying nothing about the name given to the fertilized body, we must protest that "scarcely" is not the word to qualify the observation.

Perhaps it is too much to ask that the headmaster of a "high school" should be acquainted with even remotely recent discoveries in physiological botany; but it would not be unreasonable to ask him to use the text-books of specialists. It is now some years since the reproduction of *Lycopodium* was fully described, yet Mr. Kitchener still teaches that the spores are of two sorts.

The Great World's Farm: some account of Nature's Crops and how they are Grown. By Selina Gaye. (London: Seeley, 1893.)

THIS is a delightful book, pleasantly written, full of information, and on the whole remarkably free from those errors, generally the results of misunderstanding, which

are the sins that do so easily beset writers on popular science. The volume, which contains some excellent illustrations, deals with "pioneer labourers," "soil-makers," "soil-carriers," "soil-binders," "field-labourers," "guests welcome and unwelcome," "nature's militia," and so forth. We do not propose to tell who or what the labourers, the guests, or the militia are. We advise those of our readers who are interested in the transactions of the Great World's Farm to get the volume and ascertain for themselves.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Measurement of Distances of Binary Stars.

SOME years ago I communicated to a few astronomers a plan for measuring the distance which separates us from some of the binary stars, believing, as I did, that by using the diameters of their paths as a basis, determinations of distance could be made which are impossible with the means at present in use.

This basis could, I hoped, be calculated by first ascertaining the velocities with which the stars are moving in their paths, in a somewhat similar manner to that employed for measuring the motions of stars with the spectroscope, except that instead of making a comparison with a hydrogen flame, the spectra of the two stars should be compared by photographing them together. The width of any double lines, which may show themselves (the one line belonging to the spectrum of the receding star, and the other to the advancing one) would be a measure of their velocities expressed in miles. Applying this information to the known period of revolution of the system, its diameter can also be expressed in miles, and this would enable one to estimate the distance from the earth if the angle between the two stars were known. This suggestion has already borne fruit, the relative velocity of some rapid, but as yet inseparable, binaries having recently been determined.

The answers received to my suggestions were discouraging, but since then instruments have been improved, and I trust that you will think the matter of sufficient importance to be brought before the notice of your numerous astronomical readers. Should any of them be able to make the necessary determination, a foundation-stone will have been laid, not only for obtaining a true idea of perhaps undreamt of stellar distances, but also of the masses of binary stars, and possibly a connection may ultimately be traced between them and the adjoining ones.

The two most brilliant binary stars are α Centauri and α Geminorum, and as in both these cases the paths are elongated ellipses, and the stars near their extremities, efforts should be directed towards determining their distances as suggested above. C. E. STROMEYER.

Strawberry Hill, November 16.

Remarkable Weapons of Defence.

THE following extract from a letter from such a careful observer as Mr. E. E. Green is of such general and special interest as to require publication.

Mr. R. J. Pocock informs me that the Acaroid is almost certainly *Holothyrus coccinella*, Gerv., a species that appears to be common in Mauritius, and that in the lateral membranous area between the carapace and the cephalothoracic limbs is a distinct orifice which was regarded by Dr. Thorell as of respiratory import, but in connection with Mr. Green's interesting discovery of the existence of offensive glands in this animal it is necessary to bear in mind the possibility of its being the outlet of these organs.

The mite has such a hard integument, that being taken into the mouths of the lizards and birds that would probably prey upon it in the situations it frequents, would probably do it little or no damage if it were speedily rejected. G. F. HAMPSON.

THE accompanying insects—apparently Orobatid mites—were found by me in the district of Tallawakelle, Ceylon (alt. 4600 ft.), under stones and rocks in damp, shady situations. It was only by accident that I became aware of their remarkable weapons of defence—an exceedingly pungent secretion.

About five hours after handling one of these insects I accidentally touched my tongue with my finger. Immediately an extraordinarily pungent, galvanic sensation or taste commenced rapidly to spread over my mouth, quickly reaching my throat. Rinsing my mouth and gargling with hot water failed to arrest the progress of the sensation, which was accompanied with excessive salivation. The unpleasantness lasted for several hours, and then died away without any further consequences. I also unconsciously rubbed my face, at the angle of the eye, with the same finger; after which a rather pleasant warmth spread over that part of my face, and was distinctly perceptible the following morning.

I could not for some time trace the cause of this effect. I at first put it down to the agency of a fungus that I had been carrying, but a further experiment negatived this idea. I afterwards tested the insect, and found it to be the real agent. The experiment was repeated at my suggestion, by a medical friend—Dr. R. J. Drummond—who can testify to the result. He described the sensation as somewhat like that produced by the strongest menthol. We both noticed that it had a numbing effect upon the mucous membrane of the mouth.

It is evident that this property must be a very efficient protection to the insect. The rapidity with which the secretion acts would cause it to be very quickly ejected if picked up by either a bird or a lizard—the only enemies that would be likely to attack it. E. ERNEST GREEN.

Eton, Pundulorja, November.

A Suggestion.

AS very shortly now NATURE will reach its jubilee volume, I hope you will permit me, as an uninterrupted subscriber for nearly twenty years, to offer a suggestion with regard to that occasion.

As the volumes of NATURE contain original contributions, observations, and notes in all branches of science, more varied and valuable than are to be found in any other scientific periodical publication in existence, there is not a worker, in whatever branch he may be engaged, that does not find it necessary to be continually referring to its pages; but, unfortunately, through lack of a general handy index, he discovers what he wants only after the expenditure of a very great deal of time and worry.

I write, therefore, not only in my own name, but (by request in a private way) in that of a large number of fellow-workers in the subjects in which I am myself specially interested—biology, palæontology, anthropology, geography—to suggest that you should celebrate the jubilee of NATURE by conferring on your readers the immense boon of a classified index to its contents.

During some investigations I was making in 1876-7 I so felt the need of a collected index that I went to the trouble of compiling for myself one, up to that date, classified according to sciences, subdivided again according to the sections of each, which in subsequent work saved me weeks of time and trouble. To my regret, this MS. got lost or destroyed, and there is nothing in connection with NATURE that I, and I am certain every other worker, would now hail with greater satisfaction than the announcement that the means of reaching with expedition and precision the treasures at present so deeply buried in your (nearly) fifty priceless volumes, will be ced within our reach with its jubilee volume. OLD SUBSCRIBER.

Superstitions of the Shuswaps of British Columbia.

REFERRING to the above, as recorded by Dr. George Dawson, F.R.S., in the Transactions of the Royal Society of Canada, and included in your Notes of last issue, in which attention is called to the belief among the Shuswaps and some other North American races, that small lizards enter the bodies of men, pursuing them, and devouring their hearts, I was at once struck with the almost exact resemblance of this belief to one very generally prevailing in Ireland, as regards common water Newts, which go by the name of Man-eaters (pronounced Man-aters). This I can testify to from personal knowledge; but it has been accidentally confirmed by an experiment which I hope I may be pardoned for referring to. Where I reside are three Irish servants, to whom I caused to be shown a drawing of the Water Newt, and with the request that I might be told its

name, and anything they knew about it One of these, a Galway woman, speaking Irish better than English, gave me the name in her language (which I won't attempt to transcribe, for it was a very long one), and also said that the animals were well known to jump down people's throats to their certain destruction. C. BUSHE.

Athenæum, December 24.

The Great Ice Age.

THERE is in the Astronomical theory of the Ice Age a point of some importance, not mentioned by Sir Robert Ball in his interesting work on this subject, to which I invite the reader's attention. I mean *the slowness with which the difference between the length of summer and that of winter is varying in the neighbourhood of its maximum.*

To compute this difference and its mean value, we put

a = the mean distance of the earth from the sun,
e = the eccentricity of the earth's orbit,
ω = the longitude of the perihelion of the earth's orbit,
T = the length of the year in mean solar days,
Δ = the difference between the lengths of the two seasons in mean solar days,
η = the mean value of this difference during the interval between the two dates, corresponding to $\omega = \omega_1$ and $\omega = \omega_2 > \omega_1$.

Then, the eccentricity remaining always extremely small, the difference between the areas of the two segments in which the line of the equinoxes divides the earth's orbit, may be put—and with sufficient accuracy,

$$= 2ae \,.\, 2a \sin \omega = 4a^2 e \sin \omega.$$

Hence, we find, by Kepler's first law,

$$\frac{\Delta}{T} = \frac{4a^2 e \sin \omega}{\pi a^2 \sqrt{(1 - e^2)}},$$

and consequently, by neglecting the third and higher powers of e,

$$\Delta = \frac{4Te \sin \omega}{\pi}.$$

Observing that the eccentricity remains sensibly constant for a period of time, which is doubtless to be reckoned by many tens of thousands of years, we obtain, by means of the formula just found,

$$\eta = \frac{4Te}{\pi}\int_{\omega_1}^{\omega_2} \sin \omega d\omega : \int_{\omega_1}^{\omega_2} d\omega$$

$$= \frac{4Te}{\pi} \,.\, \frac{\cos \omega_1 - \cos \omega_2}{\omega_2 - \omega_1}.$$

Finally, by substituting the numerical values of our constants, we shall have the following formulæ for computing Δ and η :—

$$\Delta = 465e \sin \omega,$$

$$\eta = \frac{465e (\cos \omega_1 - \cos \omega_2)}{\omega_2 - \omega_1},$$

positive values designating that in the Northern Hemisphere and negative values that in the Southern Hemisphere the summer exceeds the winter.

From the first formula we deduce that, for a given eccentricity, the disparity in the lengths of the seasons shall be as great as possible when the line of the equinoxes is perpendicular to the axis major of the orbit. Now, putting e = 0, 071, the maximum eccentricity, the values of Δ and η for a few values of ω are as follows :—

ω °	Δ	$\omega_2 - \omega_1$ °	η
90	... 33		
85 or 95	... 33	95 − 85	... 33
80 or 100	... 32½	100 − 80	... 33
75 or 105	... 32	105 − 75	... 32½
70 or 110	... 31	110 − 70	... 32
65 or 115	... 30	115 − 65	... 32
60 or 120	.. 28½	120 − 60	... 31½
55 or 125	... 27	125 − 55	... 31
50 or 130	... 25	130 − 50	... 30
45 or 135	... 23	135 − 45	... 29½

If we remember that the longitude of the perihelion increases in about twenty-one thousand years from 0° to 360°, then, it will be seen by inspecting these results that, for example, during the interval between the two dates corresponding to ω = 65° and ω = 115°, *i.e.* during a period of nearly three thousand years, the mean difference between summer and winter will be thirty-two days, and that during this period the difference itself will never sink below thirty days. N. L. W. A. GRAVELAAR.

Deventer, Netherlands, December 17.

Aggressive Mimicry.

IN his last letter Mr. Poulton observes that I am one of "four recent writers" who have made use of the collections in the Natural History Museum and the Museum of the Royal College of Surgeons, for the purpose of illustrating the phenomena of mimicry between *Volucella* and *Bombex.* This is the case, but I should like to add that the species which I have depicted are not *V. bombylans* and *B. muscorum* (the questionable resemblance of which in nature, and the erroneous labelling of which in the "show cases," constitute the grounds of Mr. Bateson's somewhat "aggressive" criticism on other "recent writers"), but *V. bombylans* and *B. lapidarius,* where the fact of resemblance can admit of no doubt ("Darwin and After Darwin," p. 329). Indeed, Mr. Bateson fully recognizes the close similarity in appearance between these two species; and, as I refrained from giving the hypothetical explanation of it to which he objects, I avoided all the issues which have since been raised in the NATURE correspondence.

Madeira, December 15. GEORGE J. ROMANES.

Artificially Incubated Eggs.

I HAVE been repeatedly informed by poultry-growers and market-men that hens raised from artificially incubated eggs were much less fertile than those produced in the natural way. My information has been derived from persons who did not even know each other. It occurs to me that if true it is a curious matter and worthy of some attention.

W. WHITMAN BAILEY.

Brown University Herbarium, Providence, R.I.
December 10.

THE PROPOSED UNIVERSITY FOR LONDON.

A GENERAL meeting of the Association for Promoting a Professorial University for London was held on Wednesday, December 21, when a report, which we print below, was presented by the Executive Committee. We would call the attention of our readers to the penultimate paragraph of this report, which indicates the existence of an agreement, on matters of principle between the Senate of the University of London and the Association.

The last general meeting of members of the Association was held on June 14, 1892, when the Executive Committee presented for approval a series of proposals for the organization of a University in London. These proposals were adopted as the formal expression of the objects of the Association.

Since that meeting the efforts of the Committee have been directed to the furtherance of the principles embodied in the above-mentioned proposals—by endeavouring to obtain the adhesion of literary and scientific men, and of other persons interested in the matter; by organizing a body of evidence to be presented to the Gresham University Commission, and by such other means as have suggested themselves from time to time.

Immediately after the last general meeting, Prof. Huxley became a member of the Association, and consented to accept the office of president. Sir Henry Roscoe and the Master of University College, Oxford, consented to become vice presidents; and the first of these gentlemen has since been an active member of the Executive Committee.

The number of members of the Association is now one hundred and fifty.

Evidence in support of the principles of the Association has been given before the Gresham University Commission by the following gentlemen :—Prof. Ayrton, Mr. F. V. Dickins, Prof. G. C. Foster, Principal Heath, Prof.

Henrici, Prof. Huxley, Prof. Ray Lankester, Prof. Henry Nettleship, Prof. Pearson, Sir H. Roscoe, Prof. Rücker, Dr. Russell, Prof. T. E. Thorpe, Prof. Unwin, Dr. Waller, Dr. Windle, Prof. Weldon.

During the month of November the Committee were informed that a Committee of the Senate of London University had drawn up a series of resolutions, to be submitted to the Royal Commission. Your Committee therefore requested the Vice-Chancellor to allow its members to address the Committee of the University Senate in support of the proposals of the Association. The Vice-Chancellor replied by inviting the Executive Committee of the Association to attend a meeting of the University Committee on Wednesday, December 7. At this meeting the objects of the Association were explained by the President, Sir Henry Roscoe, and Prof. Weldon, and the Vice-Chancellor in reply made an important statement, to the effect that the resolutions which were put forward by the Committee of the Senate were intended to be understood in such a manner as to render them perfectly consistent with the programme of the Association. The resolutions proposed by the University Committee, and since adopted by the whole Senate, are as follows :—

The Senate having reason to believe that a distinct expression of opinion may be useful to the Commissioners at the present stage of the inquiry, desire to recall to their attention the fact that during last year the Senate approved a Scheme for a Reconstitution of the University which provided for the constitution of Faculties consisting of teachers and of Boards of Studies in each Faculty, and for the election of members of the Senate by the Faculties; and that the Scheme further proposed to confer on the University power to hold real property and to accept grants, gifts, devises, and legacies for the purposes of the University, including the establishment of Professorships and Scholarships, whether attached or not to any particular College, and the furtherance of regular liberal education and of original research.

The Senate now desire to state that, if in accordance with the decision of the Commissioners, the Senate is prepared, in order to promote the efficiency of the University, and with a view to its reorganization as a Teaching University in and for London, without curtailment of the functions which it now discharges—

(*a*) To establish and incorporate with the University Faculties in Arts, Science, Laws, and Medicine, and Boards of Studies acting thereunder.

(*b*) To provide for the incorporation with the University of Teaching Institutions of the higher rank.

(*c*) To utilize, with their consent, existing organizations for higher culture, and subject to such utilization to institute and maintain Professorships and Lectureships, whether for academical or other purposes, and generally to assume such functions as may be required for the furtherance and superintendence of a regular liberal education, and for the promotion of original research.

(*d*) To accept and administer fees and such other funds, public or private, as may be necessary, and may be granted or given for the purposes of the reorganized University.

(*e*) To provide for the adequate representation of the Professoriate on the Senate.

The Committee regret that Prof. Pearson, whose energy and enthusiasm have been of such essential service to the Association, has felt obliged to retire from the office of Secretary. His place has been taken by Prof. Weldon.

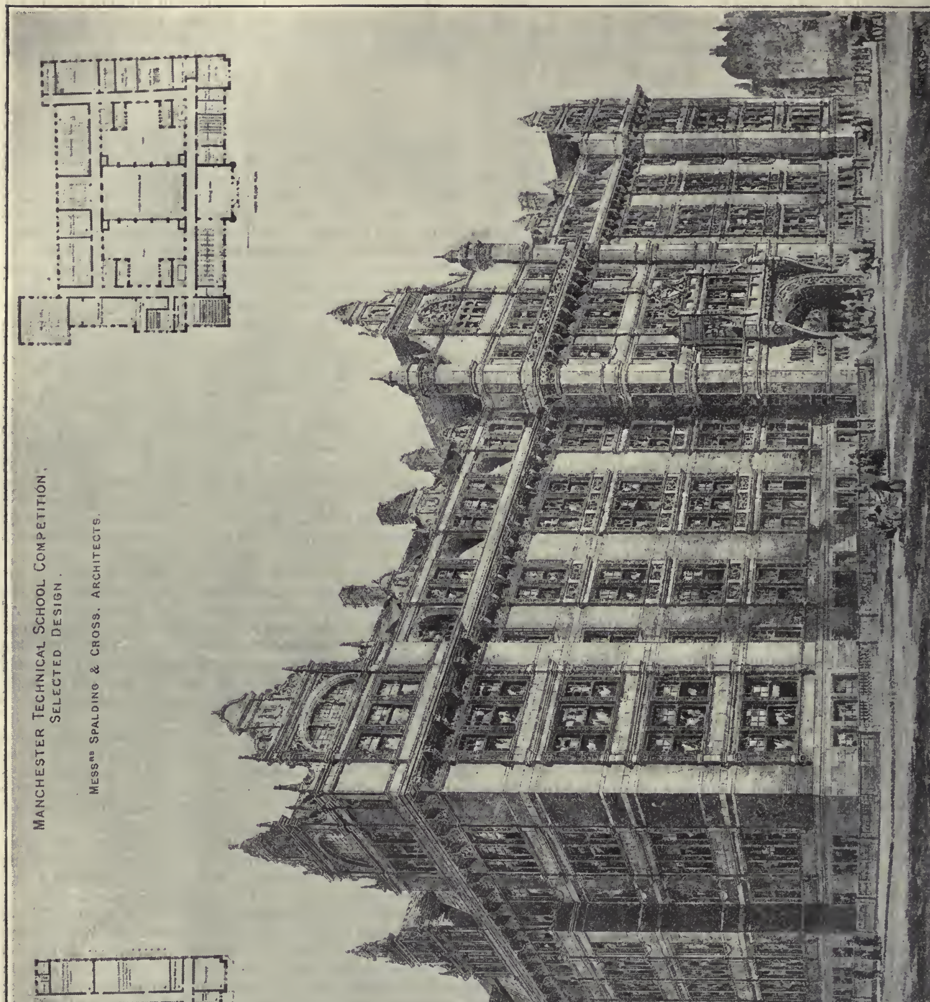
THE MANCHESTER MUNICIPAL TECHNICAL SCHOOL.

In his interesting address on technical education, when distributing the prizes of the Manchester Municipal Technical School, on the 19th inst., Mr. Balfour pointed out that the occasion was an important one, not only in the history of technical instruction in Manchester, in the history of the Corporation of that city, but also in the commercial and manufacturing history of Manchester itself, since this was the first public occasion of the distribution of prizes to the scholars of the Technical School and the School of Art since these schools were taken over by the municipality, and supported out of the public funds of the city. The fact that the Corporation of the northern metropolis has taken possession of the School of Art and of the flourishing Technical School, founded a few years ago on the site of the old Mechanics' Institution, is one which may well claim the attention of the leading statesmen of our time, and Mr. Balfour has done good service to this great educational movement by thus placing prominently before the country the part which our municipal authorities are now playing in the matter. Fully alive to the revolution which these changes are bringing about in our educational system, Mr. Balfour, speaking to the teachers and students, insisted that there is now thrown upon them something more than personal responsibility, something more than the desire for self-advancement. They are concerned, he said, in a national work, and ought to look at it from a national point of view, and it is this public aspect of the question which justifies and more than justifies the Corporation for having taken up this great work and for having created the greatest technical school at present existing in England, but which, great as it is, is still in its infancy, and will yet show developments which will astonish those who are now devoting their time to it in so public-spirited a fashion.

Then spoke Mr. Councillor Hoy, the chairman of the Technical Education Committee of the Corporation, and in thanking Mr. Balfour for his "thoughtful and charming address" added that it was only nine months since these schools were handed over to the Corporation, that they had to master the whole machinery of the education, to arrange all the details of the transfer, but that in addition they had plunged right away into the necessary steps for erecting a new and enlarged school.

So it is evident that the men of Manchester do not allow the grass to grow under their feet. They know that the business they have undertaken is a big one, and they, like good business men, are prepared boldly to meet the necessities of their position. How boldly and how completely they propose to do so will be seen when we learn what are the proposals which they have made for carrying on their work, for making the necessary preparations, for giving the highest and most complete technical training which can be given in all those matters upon the satisfactory accomplishment of which, the industry and commerce of the vast district of which Manchester is the centre depends. At present the work of the Technical School is carried on in three different buildings, one the old Mechanics Institution where the great bulk of the teaching is done, another in an old warehouse fitted to suit the wants, as far as may be, of the electrical engineering department, and a third in the buildings of a school where a very completely-equipped department for the scientific study of the cotton manufacture is arranged. Needless to say that none of these three buildings provide sufficient or adequate accommodation for the proper practical teaching and illustration of their subjects, and no sooner had the Corporation Committee become acquainted with what they had to do, and the means placed at their disposal for doing it, than they made up their minds that a new building must be erected fully representative of the present needs, and with room, if possible, for future developments.

But before committing themselves to plans or estimates, this committee wisely determined to see with their own



Manchester Technical School Competition. Selected Design.

Messrs Spalding & Cross, Architects.

eyes what was doing and had been done elsewhere. They visited the English schools, such as they are, and, more important, they went abroad and inspected the well-known technical schools on the continent, and on their return they issued an interesting report containing not only an account of what they saw and learnt, but the conclusions they drew as to how far their Manchester school should be modelled on foreign lines. This journey of inspection gave the members of the committee a new and enlarged view of their duties, and they returned home with the determination that if they could not approach the size of such buildings as the Zurich Polytechnicum or the Technical High School of Charlottenburg, at any rate they would put up a school which should be as complete in its parts as any similar institution abroad and capable of doing for their centre work equally useful and of exerting an equally beneficial influence on their population as any of the foreign schools. Some captious critics were loud in their condemnation of such a way of spending public money as that of sending a number of Manchester men on an educational tour abroad. In fact, no money could be or has been more judiciously or more economically spent. Without a knowledge from personal observation of what is doing elsewhere, these gentlemen could not possibly have carried out their business to a successful issue; with such a knowledge they can and will do it.

Fortunately for Manchester, the necessity for technical training of the people was long ago preached by one of her most distinguished sons, the late Sir Joseph Whitworth, and his legatees, knowing his views, presented a site for the school of 5000 square yards, situated in the centre of the city, and well placed as regards light and air. On this site the Corporation have decided to build a spacious, not to say magnificent, school, a perspective view of which is found on the opposite page. The whole of the site, including 770 yards in addition given by the Corporation, is to be covered by buildings, and in it ample accommodation will be found for the work carried on in the present temporary premises. This will include engineering, mechanical, electrical, civil and sanitary, the chemical industries, the cotton manufacture, spinning and weaving, the building trades, dyeing and calico printing, metallurgy, letterpress and lithographic printing, and other minor industries; industrial art and design, and the subjects classed under the heads of commercial and economical instruction. And in addition to these proper accommodation for the teaching of the pure sciences, mathematics, foreign languages, to say nothing of manual instruction and gymnastics. All these matters require means of giving practical instruction, not only lecture rooms, but laboratories, workshops, and museums, so the problem of satisfying all their needs is a complicated one, but one which the committee are determined to do their best to carry out. The size of the proposed building called forth a large number of competing designs from some of the first architects of the day, and the first premium was awarded by the Committee, assisted by Mr. Waterhouse, R.A., to Messrs. Spalding and Cross, of London. Their design is in Renaissance style of the early French period, and the internal arrangements are made with the view of giving as much light as possible. The material is red brick with terra cotta facings; it is roofed with green Whitland Abbey slates. The building will be fireproof throughout, and the flooring covered with wood blocks, except in the case of the dyehouse and laboratories, where impervious paving is needed. One great desideratum in such a building is proper ventilation; this will be arranged on the plenum or plus pressure system, the air being pumped throughout the building by fans worked by electricity, and the lighting will also be electrical. The building is six stories high, none of the rooms will be lower than 15 feet clear, and averaging from 25 to 30 feet in depth. The class rooms, lecture theatres, drawing and designing offices, laboratories, library, workshops and administrative department, as well as the students' and lecturers' rooms, are all lighted from the face of the building with wide continuous corridors all round each floor, lit from internal areas, and each department will be as far as possible separate and self-contained. The total available floor-space exceeds 150,000 square feet exclusive of the corridors. The main entrance hall is 85 by 50 feet, and it is to be utilized as an industrial museum; on the first floor is a public lecture hall 30 feet high, and of the above dimensions. On the third floor is the chemical laboratory arranged for 80 working benches. Two independent staircases, as well as a spacious passenger lift give access to the different floors, and extra exits are provided in case of fire. The basement, which is only seven feet below the ground line, is to be fitted with heavy machinery and other apparatus used in industrial operations on a considerable scale. Here we find the electrical and mechanical workshops and testing machinery; rooms for purposes in which stability is necessary; experimental steam engine, dynamo, and secondary battery rooms; spinning and weaving machinery for cotton and silk; rooms for bleaching, dyeing, and finishing; plumbers', bricksetters', and masons' workshops; shops for repairs, and construction of new apparatus, &c. The upper stories contain the laboratories, general and special, lecture rooms, drawing offices, gymnasium, library, and students' reading and common rooms.

The following is the space allotted on the various floors for the several departments:—

	Sq. feet.
1. Administration, Museum, Lecture Hall, Library, Reading Room, Gymnasium, and other offices	26,837
2. Mechanical Engineering	18,266
3. Applied Physics and Electrical Engineering	13,666
4. Textile Trades	19,211
5. Applied Chemistry, Dyeing, &c., Metallurgy	29,232
6. Building Trades	10,922
7. Letterpress and Lithographic Printing ...	2,798
8. Industrial Design	13,453
9. Commercial Subjects	11,844
10. Domestic Economy Subjects	6,461
Total	152,690

As if to indicate the determination to make the utmost of their building, the Committee have asked Sir Howard Grubb to design a small astronomical and meteorological observatory on the roof! This in the centre of smoky Manchester; but experts say that even here much useful work can be done.

The estimated cost of the building, including fittings, apparatus, and machinery is about £125.000; towards this sum the Committee have available £14,000 balance of profit from the Jubilee Exhibition; £5000 promised by the Whitworth trustees; and the property belonging to the old schools estimated at £31,000. The remainder of the sum, about £75,000, the Corporation will borrow for a period of thirty years on the security of the 1d. rate. This great school will be governed by a Committee of thirty-six persons, twenty-four of whom are members of the City Council, twelve being chosen from the public interested in the progress of Industrial and Commercial Education.

Enough has been said to give the reader an idea of the scale and completeness of the proposed Municipal School. To work this properly will cost nearly £10,000 per annum. The fees will be low, but nevertheless will bring in a goodly sum, and the funds available from the Local Taxation (Customs and Excise) Act of 1890—commonly termed the beer money—will provide the remainder. Such a school, holding as it will do an intermediate position, between the Board Schools on the one hand, and highest University Education as given in the Owens

College on the other, cannot fail to exert a most important influence on the future development of trade and manufactures in Lancashire. What Manchester is doing in this magnificent way, other towns, notably Birmingham, Salford, Stockport, Oldham, Bolton, and others, are also doing, it is true on a smaller scale, but still in a manner sufficient for their needs. How long will it be before London moves? H. E. ROSCOE.

THE MONT BLANC OBSERVATORY.[1]

THE project of establishing a meteorological and astronomical observatory on the summit of Mont Blanc has, under the care of M. J. Janssen, of the Meudon Observatory, made considerable progress during this year's summer months. It has been decided to use the snow itself as a foundation on which to rest the building. That this can be done with security was shown by some experiments carried out at Meudon last winter. A miniature mountain was made of snow pressed to the same density as that which is found on Mont Blanc at a depth of one or two metres below the surface. This being

made level at the top, discs of lead 35 cm. in diameter, and weighing each about 30 kgr., were placed on the snow, one upon the other. After twelve of these had been piled up, with an aggregate weight of 360 kgr., they were removed and the depth of the impression measured. It was not more then 7 or 8 mm. Thus a structure measuring 10 m. by 5 m. might safely weigh 187,000 kgr. without sinking into the snow more than a few centimetres.

The summit of Mont Blanc is formed by a very narrow edge of rock 100 m. long, running from west to east, and covered by snow which is thicker on the French than on the Italian side. The level of this snow has not shown any important oscillations throughout a number of years. To obviate the disturbing effects of the storms which frequently rage round the summit, the building is constructed in the shape of a truncated pyramid, the lower floor being sunk into the snow. The rectangular base measures 10 m. by 5 m. The upper floor, which will be devoted to the observations, is covered with a flat roof, towards which ascent is made by a spiral staircase leading from the basement upwards through the whole building, and above the flat roof to a small platform destined for meteorological observations.

The whole observatory has double walls to protect the observers against the cold. The windows and doors are also double, and provided on the outside with shutters closing hermetically. The floor is made of double planks, and furnished with trap-doors giving access to the snow supporting the observatory, and to the screw-jacks placed in position for adjusting the level of the building in case the snow should yield. The building will be provided with heating apparatus and all the furniture necessary to make habitation at such an altitude possible.

Up to the present the observatory has been transported in parts to Chamounix. On the Grands-Mulets a cottage has been erected for the use of the workmen and for storing the things destined for the observatory.

On the Grand Rocher Rouge another cottage has been built, only 300 m. below the summit, in which the workers and observers can, if necessary, take refuge. Three-quarters of the materials for the observatory have been transported to the Grands-Mulets (3000 m.) and the rest to the Rocher Rouge (4500 m.).

Next year the erection on the summit will be carried out. An astronomical dome, which is to complete the observatory, will also be taken in hand. The work done up to now has been carried out under great difficulties, owing to the fact that everything had to be carried by hand. But no accident has, so far, marred the success.

Dr. Capus, who accompanied M. Bonvalot in his well-known expedition to the Pamir, has promised his assistance for certain observations. But the observatory will be international, and open to all observers who wish to work there. E. E. F. d'A.

[1] Janssen, *Comptes rendus*, November 28.

M. PASTEUR'S SEVENTIETH BIRTHDAY.

FRENCHMEN may be cordially congratulated on the enthusiasm with which the seventieth birthday of M. Pasteur was celebrated on Tuesday. It afforded a most striking illustration of the way in which they appreciate the services rendered by men of science. But the celebration was not, of course, one in which only the countrymen of M. Pasteur were interested; representatives of science from many different parts of the world were present to do honour to the illustrious investigator.

The ceremony took place in the great amphitheatre of the Sorbonne, which was crowded by a brilliant assembly including many of the foremost men of the day, not merely in science but in politics and literature. M. Carnot was present, and among those who supported him was M. Dupuy, the Minister of Public Instruction. M. Pasteur entered the amphitheatre leaning upon the arm of his son and upon that of the President of the Republic. All who were present rose to their feet and greeted the hero of the day with loud cheers. M. Pasteur, who was much affected by this reception, took his place beside his colleagues of the Institute and a row of Ambassadors and Ministers.

The proceedings were opened by M. Bertrand, perpetual secretary of the Academy of Science, who acted as chairman. At his request an address was delivered by the Minister of Public Instruction, who spoke eloquently of the great qualities displayed by M. Pasteur during his splendid career, and of the benefits conferred on man-

kind by his labours. After the Minister came M. d'Abbadie, the President of the Academy, who, expressing the congratulations of the Institute, presented to M. Pasteur the large gold medal which had been struck in commemoration of the day. The medal bears on the obverse a likeness of M. Pasteur, while on the reverse is the following inscription : "To Pasteur, on his seventieth birthday, from grateful science and humanity, Dec. 27, 1892." M. Bertrand also spoke, and both his speech and that of M. d'Abbadie were cordially applauded. Sir Joseph Lister, one of the delegates sent by the Royal Society, was warmly greeted. He read in French the following address:—

"M. Pasteur, the great honour has been accorded me of offering you the homage of medicine and surgery. There is certainly not in the entire world a single person to whom medical science is more indebted than to you. Your researches on fermentation have thrown a flood of light which has illuminated the gloomy shadows of surgery, and changed the treatment of wounds from a matter of doubtful and too often disastrous empiricism into a scientific art, certain and beneficent. Owing to you, surgery has undergone a complete revolution. It has been stripped of its terrors, and its efficiency has been almost unlimitedly enlarged. But medicine owes as much to your profound and philosophic studies as does surgery. You have raised the veil which had for centuries covered infectious diseases. You have discovered and proved their microbic nature, and, thanks to your initiative, and in many cases to your own special labour, there are already a host of these destructive disorders of which we now completely know the causes. 'Felix qui potuit rerum cognoscere causas.' This knowledge has already perfected in a surprising way the diagnosis of certain plagues of the human race, and has marked out the course which must be followed in their prophylactic and curative treatment. In this way your fine discoveries of the attenuation and reinforcement of virus and of preventive inoculations serve, and will serve as a lode-star. As a brilliant illustration, I may note your studies of rabies. Their originality was so striking that, with the exception of certain ignorant people, everybody now recognizes the greatness of that which you have accomplished against this terrible malady. You have furnished a diagnosis which immediately dispels the anguish of uncertainty which formerly haunted him who had been bitten by a dog mistakenly supposed to be suffering from rabies. If this were your only claim on humanity, you would deserve its eternal gratitude. But, by your marvellous system of inoculation against rabies, you have discovered how to follow the poison after its entry into the system, and to conquer it there. M. Pasteur, infectious maladies constitute, as you know, the great majority of the maladies which afflict the human race. You can therefore understand that medicine and surgery are eager on this great occasion to offer you the profound homage of their admiration and of their gratitude."

Among other addresses was a striking speech by the Mayor of Dôle, M. Pasteur's birthplace. After the presentation of gifts by foreign delegates, M. Pasteur rose and spoke a few words, which, according to the Paris correspondent of the *Times*, were "broken by sobs." A speech was then read for him by his son. In this speech, as reported in the *Times*, M. Pasteur said, after referring to M. Carnot's presence :—"In the midst of this brilliant scene my first thought turns with melancholy to the recollection of so many scientific men who have known nothing but trials. In the past they had to struggle against the prejudices which stifled their ideas. These prejudices overcome, they encountered obstacles and difficulties of all kinds. Even a few years ago, before the public authorities and the Municipal Council had provided science with splendid buildings, a man whom I loved and admired, Claude Bernard, had for a laboratory, a few steps from here, nothing but a low, damp cellar. Perhaps it was there he was struck by the malady which carried him off. When I heard of the reception intended for me, his memory rose first of all to my mind. I hail that great memory. It seems that you have desired by an ingenious and delicate idea to make my entire life pass before my eyes. One of my Jura countrymen, the Mayor of Dôle, has brought me a photograph of the humble house where my father and mother lived under such difficulties. The presence of all the pupils of the Polytechnic School reminds me of the glowing enthusiasm with which I first entered on the pursuit of science. The representatives of the Faculty of Lille recall for me my first studies on crystallography and fermentations, which opened quite a new world to me. What hopes filled me when I discovered that there were laws behind so many obscure phenomena ! You have witnessed, my dear colleagues, by what a series of deductions I have been enabled as a disciple of the experimental method to arrive at physiological results. If I have sometimes disturbed our academies by somewhat livelier discussions, it is because I was passionately defending truth.

"You, lastly, delegates of foreign nations, who have come so far to give France a proof of sympathy, you afford me the most profound gratification which can be experienced by a man who invincibly believes that science and peace will triumph over ignorance and war ; that peoples come to an agreement not to destroy, but to build up, and that the future will belong to those who have done most for suffering humanity. I appeal to you, my dear Lister, and to you all, illustrious representatives of science, medicine, and surgery. Young men, trust those certain and powerful methods, only the first secrets of which we yet know. And all of you, whatever your career, do not allow yourselves to be infected by vilifying and barren scepticism ; do not allow yourselves to be discouraged by the gloom of certain hours which pass over a nation. Live in the serene peace of laboratories and libraries. Consider first of all, 'What have I done for my education?' and then, as you advance, 'What have I done for my country?' until the moment when you will perhaps have the immense happiness of thinking that you have contributed in some way to the progress and welfare of mankind. But whether your efforts are more or less favoured in life you must, on nearing the grand goal, be entitled to say, 'I have done what I could.' I express to you my profound emotion and warm gratitude. Just as, on the back of this medal, the great artist Roty has concealed under roses the date of birth which weighs so heavily on my life, so you have desired, my dear colleagues, to give my old age the spectacle which could most delight it—that of these eager and loving young men."

This closed the ceremony. M. Carnot, before quitting the building, walked over to M. Pasteur and embraced him. The celebration was one of which France has good reason to be proud ; and Englishmen may well regret that such a demonstration, common to governors and governed, would in this country be impossible.

NOTES.

THIS week the American Society of Naturalists has been holding at Princeton, N.J., its eleventh annual meeting, the chair being occupied by Prof. Henry F. Osborn, Columbia College, New York. On Tuesday a lecture was to be delivered by Dr. C. Hart Merriam on the Diak Valley Expedition (illustrated). On Wednesday, after the transaction of general business, the following reports on marine biological laboratories were to be read:—The Sea Isle Laboratory, by Prof. J. A. Rider, University of Pennsylvania ; a marine station in Jamaica, by

Prof. E. A. Andrews, Johns Hopkins University; the marine laboratories of Europe, by Dr. D. Bashford Dean, Columbia College; and the outlook for a marine observatory at Woods Holl, by Prof. C. O. Whitman, University of Chicago. In the evening the annual dinner of the society was to be held, and the president's address was to be delivered. The following are the principal arrangements for to-day (Thursday):—A paper is to be read by Dr. C. W. Stiles, Agricultural Bureau, Washington, on the endowment of the American table at Naples; and reports are to be read on botanical explorations in Florida, by Prof. W. P. Wilson, University of Pennsylvania; the summer work of the U. S. Fish-Commission Schooner *Grampus*, by Prof. William Libbey, Junr., Princeton College; and expeditions of the American Museum of Natural History into New Mexico, Wyoming, and Dakota, by Dr. J. L. Wortman, American Museum Natural History. Then will come the annual discussion, the subject being, What were the former areas and relations of the American Continent, as determined by faunal and floral distribution? The following papers will be read:—Introduction, and evidences from past and present distribution of mammals, by Prof. W. B. Scott, Princeton College; evidence from past and present distribution of reptiles, by Dr. George Baur, University of Chicago; evidence from the distribution of birds, by Prof. J. A. Allen, American Museum of Natural History; and evidence from the distribution of plants, by Dr. N. L. Britton, Columbia College. Special meetings have been held by the American Societies of Anatomists, Morphologists, and Physiologists.

WE learn, from the *Oesterreichische Botanische Zeitschrift*, of the death, at Vienna, of the veteran palæontologist, Dr. D. Stur, Director of the Imperial Geological Institute in that city, and author of several finely illustrated works on palæo-phytology.

DR. VOLKENS, Privatdocent at the University of Berlin, and Dr. Lent are about to start for East Africa, where they propose to carry on scientific investigations. The former has received a grant from the Prussian Academy of Sciences, and will devote himself especially to botanical study. Dr. Lent has received aid from the German Colonial Society, and will give especial attention to geology.

DR. F. BUCHANAN WHITE has presented his fine collection of lepidoptera to the Museum of the Perthshire Society of Natural Science, which is in process of being greatly enlarged. The collection contains twelve thousand specimens, which have been collected by Dr. White in many parts of Europe, though mainly in Great Britain and largely in Perthshire. Many are type specimens, which have been described and figured by the collector in his numerous descriptive papers, and several represent species that have now become extinct.

DURING the latter part of last week an area of low pressure lay to the south-westward of our islands, causing south-easterly gales on our western coasts. This disturbance, however, although it advanced from off the Atlantic, remained comparatively stationary for two or three days, during which time the weather continued fine and dry over England. At the close of the week the low pressure area gave place to an area of high barometer readings, which gradually spread over the United Kingdom from the continent, bringing dry weather and severe frost, with fog in many places. The thermometer in the shade fell to 9° in Leicestershire, and to 17° in London in the night of the 26th, and in many places the day temperature continued much below the freezing point during both Monday and Tuesday. At this time the anticyclone had become thoroughly established, and the area of cold was increasing both in size and intensity, although the conditions in the extreme north indicated a possible change. The *Weekly Weather Report* for the period ending the 24th inst. shows that temperature was above the mean in all districts, being as much as 5° or 6° over Ireland. During the early part of the week the night minima were very high for the time of year. Rainfall was less than the mean in all districts, the deficiency being most considerable in Scotland and in the south-west of England. Bright sunshine was also very deficient; in Scotland and Ireland there was only from 2 to 3 per cent. of the possible amount.

THE Weather Bureau of the U.S. Department of Agriculture has published some valuable "Observations and Experiments on the Fluctuations in the Level and Rate of Movement of Ground-water on the Wisconsin Agricultural Experiment Station Farm, and at Whitewater, Wisconsin," by Franklin H. King. The author holds that a careful and detailed study of the movements of ground-water ought to supply very important knowledge bearing upon the contamination of drinking waters and the spreading of certain classes of contagious diseases, and thus help to place the water-supply for both urban and rural purposes under better sanitary conditions. Every advance which is made towards the increase of yield per acre necessarily means an increased demand for water, so that market gardeners even in Wisconsin and Illinois, where both the annual and summer rainfall is relatively large, are turning their attention, Mr. King says, to the question as to the best means for providing irrigation. A rapid and economical advance in this direction demands, he thinks, a much more thorough knowledge of the movements of underground water than we at present possess. He also urges that in the utilization of natural sub-irrigation, and in the reclaiming of swamp lands for agricultural purposes, there is imminent need for new knowledge in the same direction. Mr. King does not overrate the importance of his own researches. He regards them simply as preliminary studies.

H. HABENICHT, of Gotha, has contributed a paper to *Ausland* (No. 49) on the frequency of icebergs in the Gulf Stream and variations of climate, based upon the reports of icebergs published since 1883 in the pilot charts of the North Atlantic Ocean. He gives a table showing the number of bergs reported in each year in the Gulf Stream, with a summary of the temperature conditions experienced in Europe during each of the four seasons. The number of icebergs varied considerably in different years, from ten in the year 1888 to 674 in the year 1890. The table shows some unmistakable coincidences between the frequency of the bergs and the character of subsequent weather about six months afterwards. The extremely low minimum of iceberg frequency in 1888 was followed by the warmest year of the series; all the seasons of 1889 were warm over Europe. There was another less marked minimum of icebergs in 1889, and this was followed by a relatively warm year in 1890. The remarkable maximum of bergs in 1890 was followed in 1891 by the coldest winter that had occurred for twenty years, and the cold winter was followed by an abnormally cold spring and summer. The table also shows that the coincidences are more marked with iceberg maxima than with minima. Two of the latter in two successive years were followed by only one warm summer, while in the case of the maxima the decrease of temperature occurred in the next year.

MR. D. T. MACDOUGAL contributes to *Science*, December 2, an interesting account of some explorations recently made by a botanical expedition in Idaho. The work of the expedition was planned by Dr. G. Z. Vasey, chief botanist of the U.S. Department of Agriculture. The results are summarized thus:—The basins of Lakes Coeur d'Alene and Pend d'Oreille and of the Clearwater and Palouse rivers were explored; the botanically unknown area in Central Idaho now being limited on the south by the Snake River basin, on the west by the Snake River

and the basin explored. About 25,000 specimens of dried plants were collected, representing nearly 1000 species, many of them undescribed forms. Valuable facts concerning general distribution of plants were obtained, since the area explored is one where the Rocky Mountain flora meets and intermingles with the Pacific coast flora in a very interesting manner, while the opportunity afforded by numerous mountain slopes for the furthering of some problems of vertical distribution was not neglected.

An important paper on fossil mammals of the Wahsatch and Wind River Beds, by H. F. Osborn and J. L. Wortman, has been issued as a bulletin by the American Museum of Natural History, and has also been published separately. It includes a plate and eighteen figures in the text, and is devoted principally to a description of a collection made by Dr. Wortman during the summer of 1891. The authors claim that many new facts of great interest are brought out by the material in the collection. In a preliminary note it is stated that the department of mammalian palæontology in the American Museum of Natural History was established in May, 1891, and that the purpose of the trustees is to procure a representative collection of the American fossil mammals from the successive geological horizons of the West for purposes of exhibition, study and publication. The staff consists of Prof. H. F. Osborn, of Columbia College, Curator, and of Dr. J. L. Wortman, assistant in Palæontology. Mr. Charles Earle and Mr. O. A. Peterson are also engaged as assistants, and Mr. Rudolph Weber as draughtsman. The collections are to be made readily accessible to students, and exhibited as rapidly as they can be put together and mounted. A list of such duplicate specimens as are available for purposes of exchange is to be prepared. A series of casts of the best preserved types is also in preparation for exchange.

Last week we printed an account of the ceremonies connected with the Tercentenary of Galileo at Padua. In addition to what was then stated we may say that after Prof. Favaro's oration the delegates were invited to present the addresses of which they were the bearers; whereupon, the English delegation having by lot been placed first in order of precedence, at the request of his colleagues, Profs. Darwin and Stone of Cambridge and Oxford, Sir Joseph Fayrer spoke first, on presenting the addresses of the Royal College of Physicians of London and the University of Edinburgh, with which he was entrusted. He spoke in Italian to the following effect:—

"Profondamente commosso all'onore accordatomi dal Reale Collegio dei Medici di Londra, ed anche dall Università di Edinburgo, nel nominarmi il loro delegato, io mi presento davanti a questa insegne adunanza, per far onore alla memoria di uno dei più grandi uomini e dei più illustri sapienti del mondo, e per render omaggio da parte del detto Collegio, così bene come dell' illustre centro di scienza e di filosofia in Scozia, all' inclito scienzato, nonche a felicitare di cuore colla massima riverenza, questo antico seggio di scienza e di filosofia in così lieta e fausta occasione, nella quale si commemorano le scoperte gloriose del celebre e rinomato filosofo, col nome del quale è intimamente collegata la sua storia passata ed anche la sua rinomanza attuale. La scienza di tutto il mondo è senza dubbio in questo luogo ora rappresentata. Da ogni parte sono venuti messaggi di simpatia, ma da nessuno forse, con maggiore premura e zelo che dei compatrioti di Harvey e Newton. Questi, impugnando la facciola caduta dalla mano morta di Galileo, la innalzò e la sostenne per illuminare le tenebre e rischiarare di vera luce i luoghi finallora oscuri anche al gran filosofo stesso; l'altro avendo terminato i suoi studi ed essendo laureato in questa università, divenne dipoi, come socio del Collegio di Londra, famoso per le sue scoperte sulla circolazione del sangue. I suoi studi anatomici che fece a Padova svilupparono in lui quel genio al quale il mondo intero è debitore. Signori miei, non è solo allo scopritore del termometro, e, come si può dire, all' inventore del telescopio; non è neppure all' astronomo famoso che ha stabilito il sistema eliocentrico, ed ha quasi anticipato le scoperte di Kepler, e che ha dimostrato i satelliti di Giove, le fasi del pianeta Venere, i movimenti diurni e mensili della luna e le macchie solari; non è infine all' autore del 'Saggiatore,' del 'Sidereus Nuncius' e del 'Dialogo dei due Massimi sistemi del Mondo,'—ma è piuttosto al fondatore della filosofia sperimentale che noi rendiamo adesso omaggio ed onore. Egli, osando, pensare ed investigari da se stesso, rigettando gli assiomi degli antichi sistemi di filosofia, anche quello di Aristotile stesso, e rifiutando gl' insegnamenti della teologia dogmatica, stabilì il sistema del libero esame, affermando che la scoperta della verità dev' essere il primo motivo, e che si deve cercarla per via di sperimenti e non sull' altrui autorità, e che la verità è unica, tanto in respetto alle scienze divine come alle umane. Ardisco dire che nessun migliore tributo si può fare al gran maestro adesso commemorato, che questa riconoscenza festiva dopo trecento anni, dell' assiduo e instancabile lavoro che ha rovesciato non soltanto il sistema Tolomaico, ma ha dato un nuovo impulso vitale ad ogni ricerca scientifica e filosofica. Signori, con queste poche parole ho tentato d'esprimere i sentimenti dell' illustre Collegio e dell' inclita Università dei quali io sono il modesto interprete, e ho l'onore di sommettere queste indirizzi, e con esse, i voti più sinceri dei miei colleghi per la prosperità futura di questa venerabile Università, la quale, molto avanti a Galileo è stata un primo centro della vita intellettuale in Europa, e che anche adesso e famosa per la sua propria eccellenza e pei suoi rapporti col gran savio di cui si può dire, come ha detto Dante di Aristotile: 'Tutti l'ammiron, tutti onor gli fanno.'"

Prof. Darwin of Cambridge followed Sir Joseph Fayrer with an interesting and eloquent address, also in Italian. He was succeeded by other delegates. We may note that every attention was shown to the foreign delegates, and the great success of the commemoration was courteously assigned by the University authorities in large measure to the sympathy and interest evinced by other nations. It is satisfactory that no inconsiderable share of this was attributed to the English; their addresses being delivered in Italian evidently afforded much pleasure.

The *Mediterranean Naturalist*, noting the fact that new and spacious buildings are about to take the place of the old biological station at Cette, expresses regret that no institution of this kind has yet been established in connection with the Maltese Islands. It points out that the marine fauna and flora of Maltese waters offer themselves as a rich and practically untouched field of research, the careful working out of which would be attended with scientific and economic results of the greatest importance.

The same journal mentions that a petition is to be presented to the Governor of Malta praying that the Maltese fisheries may be more efficiently protected. At present considerable latitude is allowed both as regards the methods practised and as regards the times at which the fishing is carried on. "This," says our contemporary, "is not as it should be. No other food supply can take the place of fish, and the fisheries of the islands under adequate protection and judicious management will always be an unfailing and increasing source of wealth."

The Department of Public Instruction in New South Wales has published in its Technical Education Series (No. 10) the first part of what promises to be a most valuable "Bibliography of Australian Economic Botany," by J. H. Maiden, curator of the Technological Museum, Sydney. Much information on the properties and uses of Australian plants, and on the products obtained from them is embodied in books of travel, in exhibition literature, pamphlets, proceedings of learned societies, professional journals, and newspapers. It is the author's object to render this scattered information convenient for reference.

A German translation, by Count Goertz-Wrisberg, of Dr. W. Fream's "Elements of Agriculture," has been published by

Paul Parey, of Berlin, under the title of "Landwirtschaft in England."

THE current number of Wundt's *Philosophische Studien* contains two experimental articles—both dealing with problems of psychological optics. The first (A. Kirschmann, "Beitraege zur Kenntniss der Farbenblindheit") gives an account of a number of interesting cases of colour-blindness, together with criticisms of existing theories. A unique case is that of an inherited, unilateral (left) blindness to the qualities violet, green and yellow. In the second (E. B. Titchener, "Ueber binoculare Wirkungen monocularer Reize") an attempt is made to show that stimulation of one retina is followed by an excitation-process in the other. The psychophysical results are supported by recent physiological discovery.

THE following are the arrangements at the Royal Institution for the Friday evening meetings before Easter, 1893:—Friday, January 20, Prof. Dewar, F.R.S., liquid atmospheric air; Friday, January 27, Francis Galton, F.R.S., the just-perceptible difference; Friday, February 3, Alexander Siemens theory and practice in electrical science (with experimental illustrations); Friday, February 10, Prof. Charles Stewart, some associated organisms; Friday, February 17, Prof. A. H. Church, F.R.S., turacin, a remarkable animal pigment containing copper; Friday, February 24, Edward Hopkinson, electrical railways; Friday, March 3, George Simonds, sculpture considered apart from archæology; Friday, March 10, Sir Herbert Maxwell, early myth and late romance; and Friday, March 17, William James Russell, F.R.S., ancient Egyptian pigments. On Friday, March 24, a discourse will be delivered by Lord Rayleigh. On March 31 and April 7 (the Fridays in Passion and Easter Weeks) there will be no evening meetings.

THE following are the arrangements for lectures at the Royal Victoria Hall in January:—January 3, Mr. Charles E. Reade on a trip through India, with anecdotes of the mutiny; January 10, Mr. A. Hilliard Atteridge on some old Belgian towns; January 17, Prof. Carlton Lambert on the romance of the stars; January 24, Dr. Dallinger on spiders, their work and their wisdom.

THE fermentative changes which the leaves of the tobacco plant are made to undergo before they are worked up and finally handed over to the public, are of the greatest importance in determining the quality of any particular tobacco. It was formerly supposed that the alteration in its condition thus brought about was due to purely chemical changes induced by the process of "sweating" which the leaf undergoes, but some interesting experiments made recently go to show that these important results are effected by special micro-organisms. In a paper read before the German Botanical Society, Suchsland gives an account of some investigations which he has been conducting on the bacteria found in different kinds of tobacco. He has examined fermented tobacco from all parts of the world, and found large numbers of micro-organisms, although but few varieties, mostly only two or three different species in any particular brand and but rarely micrococcus forms. But what is of especial interest is the discovery that pure cultures of bacteria obtained from one kind of tobacco and inoculated on to another kind, generated in the latter a taste and aroma recalling the taste and aroma of the original tobacco from which the pure cultures had been in the first instance procured. Thus it may be possible in the future to raise the quality of German tobacco, not, as heretofore, so much by careful culture and judicious selection of varieties, which has so far proved unsuccessful, but by inoculating pure cultures of bacteria found in some of the fine foreign tobaccos on to our own raw material, whereby similar fermentative changes may be induced and the quality correspondingly improved. The further results promised by Suchsland will be looked for with much interest. In connection with the above experiments on the "transplantation," so to speak, of micro-organisms, it is interesting to note some results obtained lately by Nathan (*Die Bedeutung der Hefenreinzucht für die Obstweinbereitung*). The amount of alcohol present in such wines as cider, currant wine, etc., is generally from 3 to 4 per cent. This small proportion is possibly in part due to the necessarily large dilution of the fruit with water, which considerably reduces the nitrogenous constituents of the "must," and also to the fact that the yeast, according to Hansen mostly present on sweet fruits is the *Saccharomyces apiculatus*, which only possesses a feeble fermentative power. Experiments were made to see whether, by increasing the nitrogenous constituents of the "must," and introducing a pure cultivation of a vigorous wine-yeast, the yield of alcohol would be greater. It was found that by adding a small amount of nitrogenous material, such as 0·15 gram. ammonium chloride, and 5 cubic centimetres of wine-yeast per litre to the "apple-must" (which was the fruit selected) 2 per cent. more alcohol was obtained, and not only was this the case, but this cider possessed a finer and more vinous taste than that untreated, or which had only received an additional supply of ammonium chloride without the wine-yeast. Kosutany in a paper published in the *Landw. Versuchsstationen*, 1892, has recorded the results of his investigations on the behaviour of certain species of wine-yeast. He states that not only is the percentage of alcohol yielded very different with particular yeasts, but that also the taste, smell, and bouquet of the wine inoculated with special cultures were distinctly different according to the variety of yeast employed. It is hoped that, as in the case of tobacco so with wine, it may be possible to raise the quality by the judicious transplanting of bacteria obtained from finer brands.

THE additions to the Zoological Society's Gardens during the past week include a —— Squirrel (*Sciurus* ——) from China, presented by Mr. Julius Neumann; a Crowned Hawk Eagle (*Spizaetus coronatus*) from South Africa, presented by Mr. T. H. Mills; a Macaque Monkey (*Macacus cynomolgus* ♀) from India, deposited; three Sulphury Tyrants (*Pitangus sulphuratus*) from South America, six common Widgeons (*Mareca penelope*, 3 ♂, 3 ♀), four common Pintails (*Dafila acuta*, 2 ♂, 2 ♀), two Pintailed Sand Grouse (*Pterocles alchata*, ♂ ♀) European, purchased.

OUR ASTRONOMICAL COLUMN.

JUPITER'S FIFTH SATELLITE.—Mr. A. A. Common, in a letter to the *Times* for December 28, writes with respect to the fifth satellite of Jupiter:—

"This extremely difficult telescopic object discovered by Prof. Barnard last September at the Lick Observatory has been looked for with the 5ft. reflector on several occasions. On October 18 and on December 13 it was pretty certainly seen, by me on the first occasion, and by Mr. Albert Taylor on the second. The last two evenings (Sunday and Monday) have been very fine, and on each, between five and six o'clock, the satellite has been seen with certainty by Mr. Taylor and in glimpses by me.

"The brightness seems less than that assigned to it by Prof. Barnard, but this may be due to the very much better sky they enjoy at Mount Hamilton; the glare from Jupiter would be with them very much less, so that they would have the planet on a much darker background, and it would appear brighter than it does here.

"I have not heard of any other observations having been made out of America."

COMET BROOKS (NOVEMBER 20, 1892).—*Edinburgh Circular*, No. 36, gives the ephemeris of this comet, from which the following extract is made. This comet, according to Ber-

berich's computations, will soon commence to decrease in brightness.

Berlin, Midnight.

1892–93.	R.A. h. m. s.	Decl. ° ′	Log *r*.	Log Δ.	Br.
Dec. 30	15 57 15	58 31·0			
31	16 16 30	60 21·3	0·0820	9·8589	7·66
Jan. 1	16 38 18	62 1·9			
2	17 2 46	63 29·7	0·0812	9·8530	7·89
3	17 29 49	64 41·7			
4	17 59 0	65 34·5	0·0807	9·8521	7·95
5	18 29 40	66 5·4			

COMET HOLMES (NOVEMBER 6, 1892).—The following is a continuation of the ephemeris of this comet for the present week :—

Berlin, Midnight.

1892–3.	R.A. (app.). h. m. s.	Decl. (app.). ° ′	Log *r*.	Log Δ.
Dec. 30	1 2 22	+33 59·5		
31	3 24	57·2		
Jan. 1	4 27	55·1	0·4096	0·3284
2	5 31	53·1		
3	6 36	51·3		
4	7 42	49·6		
5	1 8 50	33 47·9	0·4119	0·3400

THE MARKINGS ON MARS.—In No. 25 of the Publications of the Astronomical Society of the Pacific, Mr. Schaeberle has a preliminary note on the question as to whether the darker and the brighter areas on Mars are water and land or *vice versâ*. Having observed the planet from June 11 up to the present time he has been led to the conclusion opposite to that of Schiaparelli, Flammarion, and other observers, and considers that after all the dark portions should be considered as land and the bright as water. In raising such a question as this Mr. Schaeberle has been very reserved, for should his opinion receive due attention, as of course it should do, and be corroborated, the planet's surface will be looked upon in quite a different light than formerly. In this note he sets forth a few of his reasons for coming to such a conclusion, and it may interest many of our readers if we state some of them briefly. If the dark markings be taken as land, would not the irregular gradations of shade be more naturally expected than if we consider them as fixed surface features? "Light reflected from a spherical surface of water in a slight state of agitation would vary uniformly in intensity. At opposition, the centre of the planet would, for a water surface, appear brightest. Observations show that within a certain distance from the edge of Mars there is a gradual increase in the steady lustre of the brighter areas towards the centre of the planet." Assuming these dark areas to be water, then they should thus be least dark near the centre, which is somewhat contrary to observation. With reference to the "canals," he says that they on this hypothesis "correspond to the ridges of mountains which are almost wholly immersed in water," while with regard to their observed doubling he remarks that they can be explained as "representing parallel ridges of which our own earth furnishes examples." As a concluding argument he takes an observed terrestrial observation, the view of the lower end of San Francisco Bay from Mount Hamilton, San Francisco being fifty miles away. At all hours of the day, he says, "the surface of San Francisco Bay (as seen from the top of Mount Hamilton) is much *brighter* than the neighbouring valley and mountains at the same distance." He further adds that the line of sight makes an angle of more than 87° with the normal to the surface of the bay, while the observer's position "varies all the way from being nearly in a direct line between the bay and the sun to the position in which the sun is nearly in the direction of the bay."

THE LICK OBSERVATORY.—Miss Milicent W. Shinn is the writer of a very interesting pamphlet on the history of the Lick Astronomical Department of the University of California. In these few pages she brings together much with regard to the early events connected with the founding of the giant refractor that is not generally known. For instance, it is curious to read how Mr. Lick wished to be immortalized by leaving bequests for costly statues of himself and his family, and when urging that such statues would be preserved for all time, was answered by Mr. Staples that "more likely we shall get into a war with Russia or somebody, and they will come round here with warships and smash the statues to pieces in bombarding the city." Mr. Lick was so struck by this, that he asked, "What shall I do with the money, then?" How this question was answered is now well known, and astronomical science was presented with the finest object-glass that was ever made.

Mr. Lick's deed prescribed that the Observatory should be "made useful in promoting science," and up to the present these words have been carried out to the letter. The big telescope has not been preserved for one side of astronomical science, but has dived into all branches, as every astronomer is aware. Not only have minute double stars been observed and measured, but the spectroscope has been employed, from which excellent results have been published, while lunar photographs, equalling, if not excelling, those that had been previously obtained, have brought to light much to set us thinking about. Jupiter's fifth moon is perhaps the latest arrival of which we have heard, and this, following just 300 years after Galileo's discovery, would alone render the Observatory famous. That the Lick Astronomical Department, during the few years of its existence, has done an immense amount of good work, especially when one takes into account the comparatively small staff on hand, cannot be denied, and we hope the day will come when the number of such telescopes will be increased, for the ever-opening fields of research point out how necessary they are.

WASHINGTON MAGNETIC OBSERVATIONS.—The United States Naval Observatory has quite recently published their magnetic observations that were made during the past year, prepared on the same plan as that for 1889–90. The observations for 1891, as Mr. Hoogewerff (who was in charge for the greater part of the year) informs us, are better than those of former years, owing to the fact that the reductions took place at no very distant dates from the observations, the experience thus gained helping to correct and guard against conditions which might have tended to give rise to errors. The introduction contains a description of the buildings, methods of observing, together with the personnel during the year, concluding with a description of the tabular results. The tabular results, as usual, show the mean hourly readings for the elements for each month, Table I. containing the mean values for the four years 1888–91.

Simultaneous with this volume was also issued the meteorological observations and results for the year 1888.

GEOGRAPHICAL NOTES.

A SPECIAL number of the *Mouvement Géographique* is devoted to a series of important despatches from M. Alexandre Delcommune, chief of the Lomami expedition of the Katanga Company. Entering the Lomami from the Congo, the party left the river on May 13, 1891, and explored the entirely untraversed territory between its upper valley river and that of the Sankuru as far as 8° S. Thence they turned eastward and reached Lake Kassali on the Lualaba, and struck south through Garenganze's country to Bunkeia. Making a circuit through Katanga and westward, they found the Lualaba near its source, and following it for 200 kilometres, discovered a grand gorge at Nzole, where the river flowed in a succession of wild cataracts between cliffs nearly a thousand feet high, and not more than forty yards apart. From the rapids they returned to Bunkeia, travelled north-eastward over the plateau, crossing the Luapula at its outflow from Lake Moero, and ultimately reached Lake Tanganyika. The difficulties overcome were very great, and the sufferings of the caravan have rarely been surpassed even in the grimmest records of African travel.

AMONGST the English travellers who have recently arrived in London are Mr. Selous, the famous South African hunter, and Mr. Conway, who has probably climbed higher than any other European in the Karakoram range. Both gentlemen will read papers to the Royal Geographical Society early next year.

THE arrangements for the Royal Geographical Society's evening meetings after Christmas are unusually varied. Mr. Hose will describe his journey up the Burram river in Sarawak to Mount Dulit, at the first meeting in January. The second meeting will be devoted to the Island of Yezo, when Prof. Milne and Mr. Savage Landor will read papers. Papers by Captain Bower and the American traveller, Mr. Rockhill, on Tibet, will be given later; and Lieutenant Peary will personally describe

his experiences in the north of Greenland. In March Prof. Bonny will lecture on the action of ice in producing geographical forms, and there will be other papers dealing with the scientific basis of geography.

THE death of Cardinal Lavigerie on November 24 removed one of the most powerful personages who have recently influenced the geography of Africa. It is very largely on account of his labours that the French Roman Catholic missions have played so conspicuous a part in combating the slave trade, and to him also is due the formation of a much-needed Belgian Anti-slavery Society.

THE British Government having decided to relieve the East African Company from the responsibility of occupying Uganda, an Imperial commission, under the charge of Sir Gerald Portal, will set out from Mombasa as soon as it can be got ready to take over the administration of the country. Another fact of some interest is the revival by Mr. Cecil Rhodes of the idea of exploring Africa by telegraph. He proposes to lay down a line from the Cape to Uganda, and ultimately to extend it to Egypt. In a few months the South African Company's wires will have reached the mission station of Blantyre north of the Zambesi, and there are no serious physical difficulties in continuing the line to the head-waters of the Nile. The effect on the exploration of Africa will be enormous, not the least important result being the possibility of arriving at the true longitudes of places in the interior of the continent.

DEW AND FROST.

A PAMPHLET recording some interesting "Observations on Dew and Frost," by the Hon. R. Russell, has just been published by Mr. Edward Stanford. We reprint Mr. Russell's "Summary of Results":—

The observations were begun with the object of verifying the commonly received theory of dew, and with a strong feeling that the results obtained by Col. Badgeley, described in the *Proceedings of the Royal Meteorological Society* for April, 1891, opposed as they were in some measure to the accepted teaching on the subject, would not be corroborated. When, after exposing inverted glass tumblers and pans on grass and bare earth in the summer of 1891, dew was often found in surprising amount in the interior, I attributed the deposit to vaporous air which might have entered under the rim and parted with its moisture in the calm of the inclosed space. But when it was found that a tumbler pressed down into dry earth, and other vessels admitting little air from outside, were considerably bedewed in the interior; and when, further, similar vessels inverted on earthenware or metal plates were found to be very slightly or not at all bedewed inside, it became more probable that the vapour condensed in the interior of vessels over grass and garden earth had proceeded from the earth beneath. Next, it was found that china plates, admitting a flow of air between their lower surfaces and the ground, were more heavily bedewed on their lower than on their upper surfaces, and that a cylinder of glass was most bedewed on the lower outer and upper inner surfaces. These observations confirmed the suspicion that the dew on the inside of the hollow vessels was derived from the ground. It was for a long time a matter of doubt and difficulty that vessels inverted over dry, dusty earth and dry turf were found copiously bedewed within on the morning following exposure. On many mornings the amount of dew in the interior increased in some proportion to the precautions taken to exclude free air, and it seemed highly improbable that moist air penetrated, without depositing on its way much of its moisture, either through the dusty earth banked round the edges of the vessel, and exposed to the sky, or else through the dusty covering of earth below the vessel from lower layers.

In December, 1891, during hard frost and very fine weather, with calm or very light airs, the ground being frozen hard, leaves of bushes, ferns, &c., were seen to be frosted both on their upper and lower sides, though much less on the lower sides facing the bare ground than on the upper sides facing the open sky. Where thick fern grew between the observed leaves and the ground, there was no rime on the lower sides of the overhanging ferns or leaves. This seemed to show that the rime on the lower sides of ferns was due to exhalation from the ground, for the interruption of radiant heat from the earth by dry litter would rather favour than reduce the frosting of the under sides. Live leaves on bushes, and dead leaves on the ground, were whitened with frost on their upper sides, and had a thin film or coat of transparent ice on their lower sides. Leaves and sticks on the ground were less frosted on the sides facing the ground than on the top. Thick planks between a few inches and one foot above the ground were about a third as much frosted on the lower as on the upper sides. Considering that the upper side of a plank 1 inch thick would fall to a considerably lower temperature by radiation than the lower side, it may be supposed that the deposition would have been largest on the lower side if they had been at the same temperature. That much frost came from the air independently of the ground, was shown by the white roofs 12 feet above the surface of the earth. On the other hand the grass was much more heavily frosted. Moreover, tumblers inverted and pressed down on dry, hard, bare earth, on sand, and on hard turf, were moderately frosted inside, besides being thickly frosted outside. The indications, on the whole, seemed to resemble those of the previous June, but the vapour condensation attributable to exhalation from the earth bore a much smaller proportion to the total deposit than in the case of dew on interior surfaces observed in summer

Boards, tiles, and stones (sandstone) in heaps were frosted on the top, and especially in cracks and indentations of the top surface, but not in the interstices between the separate pieces. Stones on the ground were sometimes not frosted at all on the top, but much on the parts against the sandy earth, and where bedded in the ground.

Further experiments in May and in the summer months of 1892 gave strong confirmation of the evidence that much dew and frost are caused by exhalation of vapour from the earth, even in dry weather.

The facts that—

(1) A large quantity of dew was invariably found on clear nights in the interior of closed vessels over grass and sand.

(2) Very little or no dew was found in the interior of vessels inverted over plates on the ground.

(3) More dew was found on the lower side of a square, slightly raised, china plate over grass or sand than on the lower side of a similar plate placed upon the first.

(4) The lower sides of stones, slates, and paper on grass or sand, were much more dewed than the upper sides. The flat wooden back of the minimum thermometer on clear evenings when lying on earth, sand, or grass was almost invariably wet before the upper surface.

(5) The lower side of plates of glass, 1 or 2 in. above grass, were as much or more bedewed than the upper sides.

(6) Leaves of bushes, leaves lying on the ground, and blades of grass were about equally bedewed on both sides.

(7) The interior of closed vessels inverted on the grass and covered with two other inverted vessels of badly-conducting substance was thickly bedewed, and the grass in the three circular inclosures also thickly bedewed.

(8) The deposit of dew on the interior of closed vessels inverted over dry garden earth was much less than over sand or turf, although the powdery condition of the earth in the morning showed that no deposit from the air had taken place on its surface during the night.

(9) Usually a greater amount of dew was deposited in the interior of vessels when the earth was moist at a little depth below the surface than when the earth was at its driest.

(10) The temperature of the space under a glass plate or other object suspended near the surface of the ground was higher than that of the upper surface of the object, and, nevertheless, a cloudy film was produced first on the lower surface,—amounted to a proof that a large part of the dew formed is derived from vapour from the earth.

Moreover, the large difference often observed between the quantity of dew deposited in the interior of a vessel inclosing a plant, and the quantity of an empty vessel, proved that much dew may be derived from the earth through plants.

Drinking glasses inverted over grassy turf, and over turf close by, from which the grass was removed, showed a similar excess of deposit on the glasses inclosing grass. More vapour was condensed on plates suspended over grass than over bare earth. In these cases the conditions are somewhat artificial, and the grass, which was covered by a suspended plate or inclosed by a glass, would be warmer than if the exposure to the sky were free, but the disturbance thus caused would tell as much against as in favour of deposition on the interior surface. It may be objected that the air in and above the grass would be colder, owing to the radiating grass, than over the bared spot, and that

therefore more dew would be deposited from the air; but this objection would scarcely be valid where a small plant was inclosed on bare earth and the deposition on the interior of the glass compared with that on a glass not inclosing a plant.

Recent investigations have proved the evaporation from plants to be very large, and since evaporation proceeds by night as well as by day, there can be no reason why a moderate proportion of the dew deposited on the surface of blades of grass and on leaves of plants generally should not be derived from the vapour which they exhale. The fact that an equal quantity of dew is deposited on glass, china, painted wood, &c., exposed to the sky to that deposited on grass, may seem to minimize the influence of plant exhalation, but we must remember that the whole of the stratum of air near the ground is rendered more vaporous by these exhalations, and that therefore the dew-point is sooner reached on the surface of any body exposed to the sky in the midst of vegetation than on bare open ground. Moreover, the thickness of the substance prevents earth heat from much affecting the upper surface. The effect of grass in promoting dew formation is owing—(1) To its radiative power cooling its surface below the dew-point. (2) To the consequent cooling of the stratum of air in and over the grass to a point much below that of the air a few feet higher. (3) To the obstruction offered by the grass to any light air or breeze on a nearly calm night, and the consequent settling down, without much disturbance, of a cold heavy stratum. (4) To the prevention by the grassy covering of the drying-up process by sun and wind which takes place on bare ground, and to the moist earth which therefore exists under grass near the surface even in dry weather. (5) To the exhalation of vapour from the grass.

The realization of these causes explained what was always, previous to these observations, a difficulty to me, the almost entire absence of dew on heather and dry fern in the summer. Even after heavy dews, heather was invariably found perfectly dry. In fine, calm winter weather, with white frost, heather may be a good deal whitened, and the frost is then derived largely from the open air. Wood, being a good radiator and bad conductor, is heavily bedewed and frosted.

Stones, whether of sandy composition and appearance, or of close grain like flint, pebbles, and slate, are not often visibly bedewed or frosted on the top on clear nights. On their surfaces, touching or very close to the ground, they are heavily bedewed and frosted. A moderate radiative power, their usual situation removed from grass and vegetation, and in the case of the close grained stones, a conductive power greater than that of leaves, grass, and wood, though less than that of metals, prevent the deposition of much atmospheric moisture on their exposed sides. But when air highly charged with vapour impinges on them in a confined space, as on their lower sides, condensation readily takes place, just as it will take place when any substance, even polished metal, is held above the spout of a kettle of boiling water. It is apparent that since stones act as condensors to the vapour constantly arising from the earth, and since the heat of the sun and temperature of the air by day only slightly raise the temperature of the earth immediately beneath a large stone, while the radiation of heat from the stone and low air temperature of the night cause the lower side of the stone to be very cold at night, a rather large amount of moisture must be deposited on its lower surface in every twenty-four hours, and the ground on which it rests must in our climate remain always very moist. The space between the stone and the ground consequently becomes the abode of many insects which live well in damp and darkness.

Occasional observation of the distribution of dew, without careful comparison with the state of the weather, gives an impression of capriciousness which only continuous records comprising various conditions can remove.

Deposition is generally favoured by a humid air, and therefore in this country by southwesterly and westerly winds, which bring over the land the vapour derived from evaporation of the Atlantic Ocean. A smaller fall of temperature by radiation brings about condensation, and there is less tendency in any deposit to evaporate than in a drier air. Radiation may produce a greater fall of temperature in dry air, but the distance from the dew-point is commonly too wide to compensate greater humidity with greater cooling.

Calm is also very favourable to dew-formation. It allows parcels of vapour in the air to remain sufficiently long in contact with cold radiating substances to become greatly cooled, and so to become condensed upon them, and it prevents the dispersion of the stratum of air near the ground, which is continually cooling by contact and radiation. Thus dew goes on forming while the air falls lower and lower beyond its original dew point, and while by a very gentle movement an interchange is kept up between the warmer air touching the ground beneath the grass, and the cold air on the surface of the grass, and between differently cooled layers and portions of air above it. If the air is very humid, a very slight air or breeze is favourable to heavy deposition. On ordinary clear nights, calm and light airs allow the reduction of the lowest stratum of air to the dew-point, and there is no liability to evaporation of the minute deposited particles by portions of air above the dew-point being driven against them. When the air is rather dry, as often happens at night in dry summer weather, and in winter frosts, calm is frequently a necessary condition for the deposit and appearance of dew and white frost. The deposit may be observed to take place on the cessation of wind, and again, the change from calm to wind soon dries off the dew which has already formed. On other occasions, when there is a gentle air or breeze, dew and frost are deposited only in sheltered places, as on the most sheltered slopes of fields, on banks sloping to leeward, on leaves on the lee side of bushes and trees, on the lee side of mole-hills, posts, railings, and other objects. Hollows, depressions, and cracks, in paper, glass, stones, tiles, wood, and leaves, are more bedewed than flat surfaces from the same reason,—the reduction below the dew-point of air less diluted than that which is more free by currents of higher temperature and greater dryness. With a fresh west wind in a clear night, the raised and ribbed parts of leaves, &c., may be thickly bedewed and frosted, but the hollows and folds scarcely if at all less, and the sides of buds, thorns, &c., are more frosted than the points. The wind is, in fact, often sufficiently removed from the dew-point to prevent deposition or continuance of moisture on all parts which are fully exposed to it. Not even free radiation to a clear sky then avails to plant frost-growths upon the object whose temperature is being perpetually supplied by the forcible impact of warmer air.

Free radiation or exposed situation is, on the whole, perhaps the most effectual cause of dew on very many nights in the year. In a level country those parts of a field which are least sheltered by trees and hedges gather most dew and frost on calm nights. Similarly, those parts of any flat substance, such as a sheet of glass or paper, which have the most uninterrupted exposure to the sky are most bedewed. The tops of bushes, posts, railings, inverted drinking glasses, pans, &c., are on calm nights, and sometimes breezy nights, more bedewed than the sides. Greater cold by greater radiation in these cases produces greater deposition from the cooled air which comes in contact with the freely radiating surfaces. It must be remarked, however, that radiation from fine points, such as the tips of sharp thorns, is often not sufficient to counteract in air which is not very humid the effect of the continual impact of air above the dew-point and higher in temperature. Close to the ground the case is different, for there the temperature of the low stratum of air is lower, and usually about the dew-point, there is little movement, and vapour from the ground increases humidity; but even in this situation the points of grasses, &c., are often less bedewed than the sides.

That free radiation is by no means necessary for the formation of heavy dew on grass is proved by the experiments detailed above, made during the summer of 1892. The grass was found heavily bedewed in dry weather within three enclosures of earthenware by which radiation was arrested.

Since grass covered by hollow vessels, and the interior of hollow vessels themselves, are thickly covered with dew, it would seem likely that the grass under overhanging trees would be as thickly bedewed as the exposed grass in a field, and that the under sides of the overhanging leaves would also be wetted. This is not the case. And there are differences in the two situations sufficient to account for the absence of dew under leafy trees. In the first place, on a calm night, the air under a tree is warmer than in the open owing to radiation from the ground being arrested. Secondly, whatever vapour escapes from the earth is unable to condense on the grass which covers it, the grass being but little colder than the air and vapour. Thirdly, and herein lies the chief difference, the air under the tree moves freely and is above the dew-point, since the earth and other objects which it touches are warmer than the grass and air outside. If the air were confined in a small space, the increments of vapour issuing from the earth, and the gradual cooling of the grass under the tree and of the tree itself, might cause deposition, but air which has parted with much of its moisture outside is

constantly mixing with a considerable body of air already warmed under the sheltering canopy. Thus all objects under the tree remain above or not much below the dew-point of the air which touches them. Yet, on a calm night, long grass and other substances a little raised above the ground are sometimes heavily bedewed, though largely hindered by overhanging branches from losing their heat by radiation. They often remain nearly dry till the morning hours, and then reach a temperature below the dew-point. The absence of dew under trees and bushes is, within limits, roughly proportional to the area of ground covered. A large surface of dry ground slowly parting with its heat during the night has a powerful effect in preventing condensation. Small bushes on a humid clear night are often much bedewed even on their lower leaves. On the night of October 5, 1892, both sides of the leaves of bushes in all sheltered situations were found thickly bedewed, but where leaves were either exposed to the slight breeze which was blowing, or near the wall of the house on which the sun had shone, they were dry. The warm, dry wall of a house acts a part similar to that of the earth under a tree in radiating warmth to neighbouring objects, and in warming the air by contact. The vapour emerging from earth sheltered by foliage several feet above it has time to mix well with air before coming in contact with solid objects. In the hollow vessels, and even in the space between a raised plate of glass and the earth, the vapour which rises from the earth has no time to become equally distributed in the air before meeting with substances colder than itself; in the closed vessels the initial amount of vapour is augmented so as to produce constant saturation. Objects, such as drinking-glasses, raised several feet above the grass, were seldom much bedewed, and often quite dry.

The increase of pasture-land in England must have a considerable effect in increasing cold by radiation, and in diminishing the amount of vapour in the air at night by deposition on grass. The sensible moisture at night must be increased near the ground, the dew-point being quickly reached on a clear night over grass.

The large quantity of dew found on plates and other objects over sandy ground, dry to a depth of several inches, proves the possibility of a large emanation of noxious vapours from soil containing decaying organic matter below a covering of sand. The ague of parts of East Anglia and of sandy malarious districts may be thus accounted for.

Houses built on sandy ground over a damp subsoil may be considered as scarcely more wholesome than if built on the damp soil itself.

In late summer and early autumn the high temperature of the soil in comparison with the temperature of the surface and of the air near the ground at night, must have a powerful effect in the production of vaporous exhalations. The heavy rains which so often occur in October, the wettest month of the year, must cooperate with a falling air-temperature in driving out air from the pores of the earth.

In nearly all the conclusions of Wells, as stated in his admirable "Essay on Dew," my observations lead me to concur. He found that calm is favourable to the precipitation of dew; that if, in the course of the night, the weather, from being calm and serene, became windy and cloudy, not only did dew cease to form, but that which had formed either disappeared or diminished considerably; that if the clouds were high and the weather calm, dew sometimes formed to no very inconsiderable extent; that dew often forms on shaded grass even several hours before sunset, and continues to form after sunrise; that, if the weather be favourable, more dew forms a little before, and, in shaded places, a little after sunrise, than at any other time; that on substances elevated a few feet above the ground it forms much later in the evening, but continues to form as long after the rising of the sun as upon the ground; that dew is more abundant shortly after rain than during a long tract of dry weather; that dew is always very copious on those clear and calm nights which are followed by misty or foggy mornings, and also on clear mornings after cloudy nights, and generally after hot days; that more dew was formed between midnight and sunrise than between sunset and midnight, owing doubtless "to the cold of the atmosphere being greater in the latter than in the prior part of the night;" that whatever diminishes the view of the sky diminishes the quantity of dew; that a substance placed on a raised board of some extent acquired more dew on a very still night than a similar substance lying on grass; that bright metals attract dew much less powerfully than other bodies, that a metal which has been purposely moistened will often become dry though similarly exposed with bodies which are attracting dew, and that wool laid upon a metal acquires much less dew than an equal quantity laid upon grass in the immediate vicinity; that a metal plate on grass always became moist on the lower side during the night, though the upper side was often very dry, but that if the plate was elevated several feet in the air, the condition of both sides was always the same, whether dry or moist; that wool on a raised board was commonly colder than on the grass on very still nights, and that the leeward side of the board was colder than the windward; that bare gravel and garden mould were very much warmer after sunset than neighbouring grass; that on dewy nights the temperature of the earth half an inch or an inch beneath its surface was much warmer than the grass upon it, and than the air; that metal covering grass was only slightly colder than the grass covered, and this again colder than the earth; that metal thus exposed was warmer than air 4 feet above it, and much warmer than neighbouring grass; that the variety in the quantities of dew, formed upon bodies of the same kind in different situations, was occasioned by the diversity of temperature existing among them; and that on nights favourable to the production of dew, only a very small part of what occurs is owing to vapour rising from the earth.

The last of these conclusions Wells supported by the observation that the dew on the grass increased considerably about sunset, the same time at which dew began to show itself on the raised board, and by the reflection that, "though bodies situated on the ground after they have been made sufficiently cold by radiation to condense the vapour of the atmosphere will be able to retain the moisture which they acquire by condensing the vapour of the earth; yet, before this happens, the rising vapour must have been greatly diminished by the surface of the ground having become much colder." He adduced the fact that substances on the raised board attracted rather more dew throughout the night than substances lying on the grass. He admitted that all the dew on calm, cloudy nights might be attributed to condensation of the earth's vapour, since on such nights the raised board was dry.

But if the grass was moist on these calm, cloudy nights, and the moisture were owing to earth-vapour, it is only reasonable to infer that a very much larger quantity was owing to earth-vapour on clear nights when radiation was comparatively free. Moreover, the fact that substances on the raised board became wetter than substances on the grass may be attributed to the non-conducting wood intercepting the warmth radiated from the ground, and thus allowing a substance on the upper surface of the board to become colder than a substance on the grass. And with regard to the "rising vapour" being greatly diminished by the surface of the ground having become colder, it does not appear that such diminution actually occurs, owing possibly to the influence of the high temperature of the preceding day reaching the moist earth at a little depth below the surface about the same time. I have found the deposition of earth-vapour to proceed at a rapid rate after sunrise over grass.

Wells explains with much ingenuity the reason why leaves of trees often remain dry throughout the night, while those of grass are covered with dew. But he does not, I think, attach sufficient weight to the fact which he mentions among others, that the air near the ground is near one of its sources of moisture, while the tops of trees are removed from that source. The air is both damper and colder near the ground; a stratum of cooled air rests upon warm earth emitting vapour. The tops of trees are pervaded by air which is drier and warmer, and the leaves do not allow air to rest long enough on their cooled surfaces to part with sufficient heat in order that condensation may ensue.

I have found that when the air is clear and not humid, radiation into space is often not sufficient to cause visible dew or frost except in sheltered calm places, and in the same condition of air deposition takes place more on broad surfaces than on thin shoots, threads, and points, and more on the faces than on the edges of leaves. It appears necessary that a certain stability of temperature below that of the air, and a certain protection from re-absorption by the drier portions of air which pass over, should be attained in order that dew and frost may accumulate. When, on the other hand, the air is very moist, with a tendency to mist or fog, a very large condensation takes place on exposed objects, and especially on those which are at some height above the ground, such as the branches and twigs of trees. Points, thorns, spiders' webs, and other thin filaments are then heavily bedewed. Mist or fog often follows.

When some mist has formed on such a night, there is a heavy

precipitation on trees, &c., which is increased by wind, and large drops of rain on to the ground beneath them. This condition seems best explained by Aitken's discoveries showing the possibility of a super-saturation of air when the number of dust-particles is unusually small in a mass of air which is humid and cooled to saturation. The dust-particles from their minuteness, and from their inability to fall below the temperature of the air owing to the cloud canopy above, do not condense much of the vapour, and consequently any solid object of the same or slightly lower temperature brings about precipitation from the passing air, which may possibly be super-saturated. A slight fall of temperature in the air, or sometimes an increase of dust-particles, then produces fog. A dry fog may thus result from cold causing condensation on a very large number of dust-particles which are radiating heat rather freely, and a damp mist from partial condensation from super-saturated air on a comparatively small number of dust particles not radiating freely owing to a clouded sky.

These considerations explain why a dry fog is densest in London and a wet mist densest in the country. A dry fog is the work of cold radiating particles, a wet mist is the work of cold air mixing with warm. "In a fog," says Angus Rankin,[1] "the watery vapour in condensing has more particles to condense on, and consequently the particles of fog are smaller, and on meeting with an object with a higher temperature, instead of wetting it, the object dries them up by parting with some of its heat. On the other hand, in a mist, the particles of dust, being few, have more water condensed on each, and so are larger and do not readily evaporate with small increments of heat." Yet in a damp mist the addition of a large number of dust-particles, as in a town by day, scarcely increases the density of the mist. In fact, the wet mist is less dense in London than in the country, owing to the higher temperature and lower humidity of the air. Dry or radiation fogs, which cling to the ground, are the most dense in smoky places.

In fogs with frost in winter, such as have occurred several times in the last few years, I have always found the windward side of objects to be much more heavily frosted than the leeward, and the rime to attach itself most to points and edges. Trees have thus become laden with rime, even so as to break down branches; iron points of railings, splinters of wood, wires, and blades of grass have borne spikes and fern-like growths an inch or more long, and heather and fern in hollows have been whitened as if with a fall of snow. In weather of this kind it is difficult to say what is dew or frost proper, and what is deposited moisture from super-saturated air and from fog. On the same night a white frost may present the characteristics of fog-deposition in a valley and of clear condensation on a neighbouring hill.

Dew and frost are in fine the result of many causes which inter-operate in a complex manner. The importance of the laws of gases of the multitude of fine adaptations in the relations of vapour, air, water, earth, and plants; the importance, too, of the thermal receptivity of boundless space, gives an interest to this branch of meteorology which is second only to its beauty.

[1] *Journal of the Scottish Meteorological Society*. Third Series. No. viii

ARBORESCENT FROST PATTERNS.

PROF. MELDOLA'S account of Arborescent Frost Patterns has excited a good deal of interest, and we have received many letters on the subject, some of which we have already published. To-day we give reproductions of photographs we have received from Mr. J. Maclear, Cranleigh. Fig. 1 represents a photograph of a facsimile tracing of a "Nature print" of an ice crystallite taken by Mr. A. Anderson on a still and sunny early morning in January 1887, after a not very severe frost. The sunshine had just dried the rest of the frost off the flagstone, and left this mud and ice-crystallization, which he promptly secured on soft paper by means of a soft pad-pressure, and thus got a perfec Nature printed impression. The original (now unfortunately lost) showed an appearance of vegetable (moss) growth, even more strikingly than in this tracing from it.

With regard to Fig. 2 Mr. Maclear writes:—"The melting ice under the dabbing pad formed a natural pigment with the mud on the flagstone, the rest of the flagstones being perfectly dry already by the early morning sunshine."

Prof. Meldola sends us the following interesting letter which he has received from Corbridge on-Tyne:—

"I was much interested by your note in NATURE the other day, anent the frost markings of a vegetable pattern. I have seen just the same forms several times in the north, but it is I think the least common of the patterns usually met with. I write, however, to call your attention to Figs. 1 and 7 of Plate

FIG. 1.—Ice crystallite, "Nature printed" by A Anderson, January 1887. Facsimile tracing by J. Maclear, January 1887. Size of crystal 14⅞ inches × 13⅜ inches.

vii, illustrating the article on Meteorology in the "Encyclopædia Metropolitana" (1845, vol. i. of plates, vol. v. of text). These figures are very like yours and some of the others given with them are also very interesting. I have often shown my students when out in the fields in cold weather how exactly the mud-

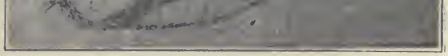


FIG 2.—Photograph from the original "Nature print," made Mr. A Anderson, of an ice crystallite, January 1887. Size of crystal, 10⅜ inches × 7 inches.

cum-frost markings of the common feathery volute type imitate the so-called *Cauda-galli* fossil fucoid (?) which is one of the most abundant objects on the surface of the carboniferous limestone courses about here. As far as form goes they are identical, and there is no structure to be discovered in the fossil markings.

"Corbridge-on-Tyne, December 16. G. A. LEBOUR."

PROF. SOLLAS writes to us:—The correspondence on this subject that has lately appeared in your columns (particularly Prof. Bonney's reference), leads me to anticipate a communication I hope shortly to present to the Royal Dublin Society on the growth of crystals. The arborescent forms assumed by ice are merely a special case of a very general problem—that of the

forms assumed by crystals under different conditions. Petrologists have long been familiar with the tendency of crystals developing in a viscid medium to excessive growth in one or more directions. Felspar is a familiar instance, the lath-like forms which it frequently assumes being due to elongation along one axis (x), the length of prisms measured along this axis often exceeding by ten times that along the axis y or z. The cause of this need not now be discussed; it will be sufficient to add that the phenomenon is not special to felspar, but is of quite general occurrence. With this tendency is connected the origin of curvilinear forms. We may consider the molecules forming the growing face of a long prism; the spheres of influence of these lie half within and half without the substance of the crystal. Considering this influence as attractive (directly or indirectly), we may say that the attraction of the molecules leading to further deposition is one-half their total attraction. If now from the face we pass to the edge between two faces at right angles, only one-quarter of the sphere will be immersed, and the attraction may be spoken of as three-quarters of the whole; while if from the edge we pass to a corner, only one-eighth is immersed, and the attraction becomes seven-eighths. From this it follows that growth should be more rapid at the edges than over the surface of the face, and still more rapid at the corners. In accordance with this we find young growing prisms in a viscid medium increasing so rapidly at the edges as to leave a space in and about the axis filled with the medium in a non-crystalline state. Indeed, a viscid medium is not necessary; hollow prisms are of common occurrence whenever crystallization takes place with rapidity. Further, in quite embryonic crystallites, Vogelsang figures elongated prism-like forms, in which the four corners are produced parallel to the long axis into processes resembling spines. There is an additional reason pointed out to me by Prof. Fitzgerald why growth should be more rapid at the edges and corners than over the general surface, and that is that these parts are more exposed to molecular bombardment.

If crystals are more readily built up along edges and corners, we should expect them to be more readily unbuilt in these regions, and this is in accordance with observation; the zonal felspars of igneous rocks, in the formation of which intervals of solution have alternated with periods of growth, usually present, in the outlines of each resulting envelope, rounded corners.

The influence of corners is well seen in some glassy rocks where small prisms of felspar (andesite) may be observed, with five or six slenderer but longer prisms springing from a corner in radiate divergence.

From this it is but a step to curvilinear growth. Let a prism tend to rapid rectilinear growth, and any check immediately in front will lead to a forward growth from a corner in a slightly different direction; even the competition of molecules for this centre of attraction may by overcrowding bring about this result, and thus both branching and curvilinear forms may arise. This is beautifully exemplified in the spherulites of many igneous rocks, where we find in the centre of a radiately crystallized sphere a long prism of felspar serving as a nucleus, and from the *ends* of this slender, almost linear, prisms diverge towards a spherical surface which by repeated branching and associated curving they everywhere reach, leaving about the sides of the nucleus a spherical space almost devoid of crystal structure. The whole arrangement in median longitudinal section presents a remarkable resemblance to the lines of force as shown by iron-filings about a bar magnet.

Evidently in rapid crystallization with a tendency to linear growth, divergence may be repeated at such frequent intervals as to produce forms which to the unaided eye appear to be continuous curves.

SOCIETIES AND ACADEMIES.

LONDON.

Mathematical Society, December 8.—Mr. A. B. Kempe, F.R.S., President, in the chair.—The following communications were made:—On a theorem in differentiation, and its application to spherical harmonics, by Dr. Hobson.—On Cauchy's condensation test for the convergency of series, by Prof. M. J. M. Hill. Cauchy's condensation test for the convergency of series is as follows:—If $f(n)$ be positive for all values of n, and constantly decrease as n increases, then the series $\Sigma f(n)$ and $\Sigma a^n f(a^n)$ are both convergent or both divergent, where a is any positive integer not less than 2. There is a clear reason why a cannot be unity, for then $\Sigma a^n f(a^n) = \Sigma f(1)$, which is always infinite. It is proved in Chrystal's "Algebra" that the theorem is also true if a have any positive fractional value not less than 2, see part 2, chapter xxvi., § 6, cor. 1. The proof there given when a lies between the consecutive positive integers p and $p + 1$ is based on Cauchy's proof for the two cases $a = p$ and $a = p + 1$. But this proof will not apply when $1 < a < 2$, because Cauchy's proof will not apply when $a = 1$. Yet it does not seem possible to assign a reason for excluding values of a between 1 and 2, for Cauchy's method appears to depend on this—viz. that for increasing values of n the expression $f(a^n)$ occupies more and more advanced positions amongst the terms of the series $\Sigma f(n)$; but this is possible if $1 < a < 2$, as well as when $a > 2$. If $a \overline{\leq} 1$, then this is no longer true. The problem then considered in this paper is so to recast the proof for fractional values of a as not to exclude the case $1 < a < 2$. The complete theorem will then stand thus:—If $f(n)$ be positive for all values of n, and constantly decrease as n increases, then the series $\Sigma f(n)$ and $\Sigma a^n f(a^n)$ are both convergent or both divergent if $a > 1$. The demonstration depends on the following theorems.

I. If $\Sigma a^n f(a^n)$ be convergent, then—

$$\sum_{n=1}^{=\infty} f(n) < f(1) + \ . \ . \ . + f(t_s)$$

$$+ (a - 1 + a^{-s}) \left[\sum_{n=1}^{n=\infty} a^n f(a^n) - \sum_{n=1}^{n=s-1} a^n f(a^n) \right]$$

where s is any integer so large that

$$a^{s+1} - a^s > 1,$$

and t_s is the greatest integer in a^s, a being greater than 1.

II (A). If $\Sigma a^n f(a^n)$ be divergent, and if $a^n f(a^n)$ diminish as n increases beyond a certain value, then

$$\sum_{n=1}^{n=\infty} f(n) > f(1) + \ . \ . \ . + f(t_s)$$

$$+ (1 - a^{-1} - a^{-s-1}) \left[\sum_{n=1}^{n=\infty} a^n f(a^n) - \sum_{n=1}^{n=s} a^n f(a^n) \right]$$

II (B.) If $\Sigma a^n f(a^n)$ be divergent, and if $a^n f(a^n)$ do not diminish as n increases beyond a certain value, then—

$$\sum_{n=1}^{n=\infty} f(n) > \sum_{n=1}^{n=s} f(n) + \sum_{n=s+1}^{n=\infty} An^{-1},$$

where s is an integer taken large enough, and A is some finite quantity.—Additional note on secondary Tucker circles, by Mr. J. Griffiths.—Notes on determinants, by Mr. J. E. Campbell. In accordance with the late Prof Smith's notation, a determinant of the p^{th} class may be written

$$| aijk \ . \ . \ . \ |$$

The fact that a determinant of the second class (an ordinary determinant) is not altered if the vertical columns be written horizontally is expressed by the identity

$$| a_{ij} | = | a_{ji} |$$

For determinants of higher class it is known that any of the suffixes can be interchanged, except the first: and if the class be even, the first suffix can also be interchanged with any other, but for determinants of odd class this is not true. By considering a cubic determinant as an ordinary determinant in alternate numbers, the author tries to explain this essential distinction between determinants of odd and even classes. If the element $a_{pqr\ldots} = -a_{qpr\ldots}$, and $a_{ppr} = 0$, the determinant is called skew symmetrical. It is easily seen that skew symmetrical determinants of even class and odd degree vanish identically. This is analogous to the well-known theorem in ordinary determinants; but there is no corresponding analogue to the theorem that skew symmetrical determinants of the second class and even

degree are perfect squares. The reasoning which establishes these propositions does not apply to skew symmetrical determinants of odd class. By a different method it is shown that they vanish identically whether the class be even or odd. It is next shown that if we form any determinant of even class $2p$ from $2p$ ordinary determinants, in a manner analogous to that in the rule for the multiplication of two ordinary determinants, the determinant so formed is the product of the $2p$ determinants; and if any determinant of odd class $2p + 1$ is formed from $2p + 1$ ordinary determinants, the determinant so formed is the product of the last $2p$ of these ordinary determinants into the first taken, with all its signs positive. A somewhat similar result is shown to hold for determinants of alternate numbers. As an application, let

$$z = \frac{a_1}{(x - \alpha_1)(y - \beta_1)} + \cdots + \frac{a_n}{(x - \alpha_n)(y - \beta_n)},$$

and let (p, q) denote

$$\frac{d^{p+q}z}{\underline{|p}\,\underline{|q}\,dx^p dy^q}.$$

By multiplying the arrays

$$\left\| \begin{matrix} \dfrac{a_1}{x - \alpha_1} \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \\ \dfrac{a_1}{(x - \alpha_1)^2} \cdot \cdot \cdot \cdot \cdot \cdot \cdot \end{matrix} \right\| \qquad \left\| \begin{matrix} \dfrac{1}{y - \beta_1} \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \\ \dfrac{1}{(y - \beta_1)^2} \cdot \cdot \cdot \cdot \cdot \cdot \end{matrix} \right\|$$

we get

$$\begin{vmatrix} (0, 0), & (0, 1) \\ (1, 0), & (1, 1) \end{vmatrix} = \Sigma \frac{a_p a_q (\alpha_p - \alpha_q)(\beta_p - \beta_q)}{(x - \alpha_p)^2 (x - \beta_p)^2 (x - \alpha_q)^2 (x - \beta_q)^2}.$$

Suppose, now, $n = 1$, we get that the primitive of

$$\begin{vmatrix} (00), & (01) \\ (10), & (11) \end{vmatrix} \text{ is } z = \frac{a_1}{(x - \alpha_1)(y - \beta_1)}.$$

Similarly, by multiplying,

$$\left\| \begin{matrix} \dfrac{a_1}{(x - \alpha_1)} \cdot \cdot \cdot \cdot \cdot \cdot \cdot \\ \dfrac{a_1}{(x - \alpha_1)^2} \cdot \cdot \cdot \cdot \cdot \cdot \\ \dfrac{a_1}{(x - \alpha_1)^3} \cdot \cdot \cdot \cdot \cdot \cdot \end{matrix} \right\| \qquad \left\| \begin{matrix} \dfrac{1}{y - \beta_1} \cdot \cdot \cdot \cdot \cdot \cdot \cdot \\ \dfrac{1}{(y - \beta_1)^2} \cdot \cdot \cdot \cdot \cdot \\ \dfrac{1}{(y - \beta_1)^3} \cdot \cdot \cdot \cdot \cdot \cdot \end{matrix} \right\|$$

we get that the primitive of

$$\begin{vmatrix} (00), & (01), & (02) \\ (10), & (11), & (12) \\ (20), & (21), & (22) \end{vmatrix} = 0,$$

is

$$z = \frac{a_1}{(x - \alpha_1)(y - \beta_1)} + \frac{a_2}{(x - \alpha_2)(y - \beta_2)}.$$

Similar primitives are obtained for differential equations, which are in the form of determinants of higher class. A further application is obtained by taking powers of different invariantive symbols, of which (123) is the simplest for the ternary quantic. The resulting invariants are seen to be determinants of some even class.—A geometrical note, by Mr. R. Tucker.—The President (Major MacMahon, F.R.S., in the chair) made an impromptu communication of a problem, the solution of which he thought would be subsidiary to the sought-for solution of the "stamp folding" problem.

Linnean Society, December 15.—Prof. Stewart, President, in the chair.—The President announced the recent death of Mr. H. T. Stainton, a Fellow and former Vice-President of the Society, and of European reputation amongst entomologists, by whom his loss would be widely felt.—Mr. D. Morris exhibited a series of botanical photographs from the west coast of Africa, and gave some interesting details about the appearance and mode of growth of some of the more remarkable forest trees and plants of that region.—The Secretary exhibited a large collection of photographs of Lichens, very neatly mounted and labelled, which had been recently presented to the Society by Prof. Arnold, of Munich.—On behalf of Mr George Swainson, of St. Annes-on-Sea, Lancashire, Mr. A. R. Hammond exhibited an aquatic dipterous larva, belonging probably to the genus *Dixa*, of which by means of the oxyhydrogen lantern, with microscopic attachment, a good figure was projected on the screen. He referred to the different views which prevailed concerning the dorsal and ventral aspects of this larva, and pointed out that the tail-plates possessed features which in allied forms were characteristic not so much of the larval as of the pupal stage.—A paper was then read by Dr. Maxwell T. Masters, F.R.S., on the classification and geographical distribution of the *Taxaceæ* and *Coniferæ*, his remarks being illustrated by a specially prepared map, lent by Mr. C. B. Clarke, and by specimens of the fruit and leaves of some of the more notable forms.—Mr. George Brook followed with a paper on the affinities of *Madrepora*, and here again, by means of the oxyhydrogen lantern, an excellent series of coral sections was projected, which illustrated very clearly the author's remarks on comparative structure.—A short note on the abnormal form of the lens in the eyes of an albino rat, by Prof. R. J. Anderson, was read on his behalf by the Secretary. The meeting then adjourned to January 19, 1893.

Zoological Society, December 6.—Dr. St. George Mivart, F.R.S., Vice-president, in the chair.—The Secretary read a report on the additions that had been made to the Society's menagerie during the month of November 1892.—Dr. Hickson read a paper entitled "A Revision of the Genera of the *Alcyonaria Stolonifera*, with a description of one new genus and several new species." The author commenced by stating the grounds upon which it might be considered desirable to retain the suborder Stolonifera, and criticized the views of those who place these Alcyonarians in the suborder Alcyonida. Of the genera that had already been proposed only four could now be retained, namely, *Tubipora*, *Clavularia*, *Cornularia*, and *Sympodium*, and the author proposed to add one more, namely, *Stereosoma*. The genera *Sarcodictyon*, *Rhizoxenia*, *Cornularieila*, *Anthelia*, and *Gymnosarca* must be abandoned, and the species incorporated in the other genera. A description was then given of the new genus *Stereosoma*, a form found on the coast of North Celebes, distinguished from all other Stolonifera by certain characters of its tentacles and by the absolute non-retractability of its polypes. Several new species of *Clavularia* were then described from North Celebes, Diego Garcia, and Australia. This was followed by a summary of all the species of the genus known to science.—Mr. F. E. Beddard, F.R.S., read a description of the convolutions of the celebral hemispheres in certain rodents. The paper referred chiefly to *Dasyprocta Cælogenys*, *Lagostomus*, *Hydrochœrus*, and *Dolichotis*, being the genera of rodents in which the brains show the greatest development of convolutions.—A communication was read from Prof. Collett, containing a description of a new monkey from S.E. Sumatra, for which he proposed the name *Semnopithecus thomasi*.—Mr. H. J. Elwes read the second portion of an account of the butterflies collected by Mr. W. Doherty in the Naga and Karen Hills and in Perak.

PARIS.

Academy of Sciences, December 19.—Annual Public Meeting.—The President, M. d'Abbadie, gave a brief survey of the life and work of those lost to the Academy by death during the year. Among these were the following members: M. D. D. A. Richet, distinguished for his medical discoveries; M. de Quatrefages de Bréau, the naturalist; M. Jurien de la Gravière, Vice-Admiral under the Empire; M. Pierre Ossian Bonnet, geometrician; Admiral Mouchez, late Director of the Paris Observatory. Foreign Associate: Sir G. B. Airy. *Académicien libre:* M. Lalanne. Correspondents: MM. Gilbert, Abria and Adams. The prizes were awarded as follows: The Grand Prize of the mathematical sciences to M. Hadamard for his solution of the problem of determining the number of primary numbers inferior to a given quantity. One Prix Bordin to M. Gabriel Koenigs for his solution of a problem concerning geodesic lines; another to M. Humbert for his work on hyperelliptic surfaces. The Prix Poncelet to the builders of the Forth Bridge, Sir John Fowler, and Sir Benjamin Baker; the Extra Prize of 6000 francs to M. Hédouin for his work on the Channel currents; the Prix Montyon to M. N. J. Raffard, civil engineer; the Prix Plumez to M. Augustin Normand, for his geometry of ships. In Astronomy, the Prix Lalande was doubled, and awarded to Mr. Barnard and Mr. Max Wolf; the Prix Damoiseau to M. Radau for his work on lunar inequalities of long period caused by planets; the Prix Valz to M. Puiseux for his researches on the *equatorial coudé* and other instruments; the Prix Janssen to M. Tacchini for his solar work. Statistics: The Prix Montyon to MM. M.

Bastié and J. Dardignac for works on the population of France and hygienic statistics respectively. Chemistry: The Prix Jecker to M. Bouchardat for his researches on the terebene carbon compounds. Mineralogy: The Prix Vaillant to M. Lacroix for his work on the application of optical characters to the determination of rocks and mineral species. Botany: The Prix Desmazières to M. Pierre Viala for his "Maladies de la Vigne"; the Prix Montagne—1000 francs to M. l'Abbé Hue, and 500 francs to Dr. F. Xavier Gillot for their mycological researches; the Prix de la Fons Mélicocq to M. Masclef for his "Botanic Geography of Northern France." Medicine and Surgery: Prix Montyon—one to MM. Farabœuf and Varnier for work on obstetric medicine, another to M. Javal for ophthalmometry, a third to M. Lucas Championnière for his work on hernia; the Prix Barbier was shared between M. Laborde ("Death by Chloroform") and MM. Cadéac and Albin Meunier ("Alcoholism," &c.); the Prix Bellion to Dr. Theodore Cotel for his work on "The Education of the Senses"; the Prix Lallemand was shared between M. Binet ("Les Altérations de la Personnalité") and M. Durand ("Les Origines Animales de l'Homme"). Physiology: the Prix Montyon to M. Hédon (diabetes) and M. Cornevin (breeding of domestic animals); the Prix Pourat to M. H. Roger for his researches on the inhibitory power of the nervous shock. Physical Geography: the Prix Gay to M. Moureaux (distribution of magnetic elements in France). General Prizes: Prix Montyon, for improvements in unhealthy industries, to M. L. Guéroult (crystal cutting); the Prix Delalande Guérineau, to M. Georges Rolland for his work on the Algerian Sahara; the Prix Jérôme Ponti, to M. Le Chatelier for his researches on dissociation and chemical equilibrium; the Prix Leconte (50,000 frcs.), to M. Villemin for his demonstration of the specific nature and the transmissibility of tuberculosis. The *Comptes rendus* contains a complete list of the prizes to be awarded in the next few years.

BERLIN.

Physical Society, November 18.—Prof. Du Bois Reymond, President, in the chair.—Prof. Neesen gave an account of experiments made with a view to the photographic recording of the oscillation of projectiles. He employed hollow projectiles in whose interior was placed a sensitive plate, illuminated by sunlight through a small opening. During its rotatory flight the ray of light described curves on the plate, from whose position, taken in conjunction with that of the sun, the oscillation of the axis and point of the projectile would be calculated. The results obtained showed that both the axis and point perform oscillatory movements during the flight which are very different from those usually believed to take place. In order to study these more accurately, Prof. Neesen is busy with the construction of some arrangement which may admit of the introduction into the projectiles of sensitive plates which shall not participate in the rotatory motion.

December 2.—Prof. Du Bois Reymond, President, in the chair.—Dr. Du Bois gave an account of experiments made by Mr. Shea in Berlin on the refraction of light in metals, and in connection with this referred to a theoretical treatise which he had recently published on the same subject in conjunction with Dr. Rubens.

Physiological Society, November 25.—Prof. Du Bois Reymond, President, in the chair.—Dr. Treitel gave an account of observations he had made on two snails enclosed in air-tight glass vessels. Dr Ad. Baginski gave an account of a very fatal epidemic among rabbits in the same hutch, in which a post-mortem examination of the dead animals showed a serious affection of the liver and intestinal mucous membrane. The liver was filled with cysts of various sizes, in which, together with coccidiæ, some very remarkable growths were found, which led to very marked changes of the epithelial cells.—Dr. Rawitz made a short preliminary statement of observations on Annulata made during his stay at the biological station of Rovigno, on the coast of the Adriatic. While one species was found to be extremely sensitive to light, and to draw in its tentacles at once when shaded, another closely related species was quite unresponsive, while, on the other hand, it reacted immediately to the slightest touch. The first species was much less sensitive to touch.

AMSTERDAM.

Royal Academy of Sciences, October 29.—Prof. van de Sande Bakhuysen in the chair.—Prof. Engelmann spoke (1) on the influence of central and reflected irritation of the nervus opticus on the movement of the cones of the retina; and (2) on the theory of the contraction of muscles.—Prof. Schoute proved the following theorem:—If $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ is the equation of a given ellipse, E, and $f(x, y)$ contains the terms of the nth order of the equation of a curve C^n with reference to the same axes. The sum A of the eccentric anomalies α_k of the $2n$ points S_k common to E and C^n is determined by the relation

$$e^{iA} = \frac{f(a, ib)}{f(a, -ib)}.$$

He indicated several peculiar cases of this general theorem.—Prof. Kamerlingh Onnes communicated some measurements, by Mr. Leeman, relating to Kerr's phenomenon when reflection takes place at the pole of a cobalt-magnet. The constancy of the difference of phase S, discovered by Dr. Sissingh was confirmed. The measurements agree with the theory of Goldhammer, contrary to that of Drude. Mr. Leeman finds a magneto-optic dispersion in S.

November 26.—Prof. van de Sande Bakhuysen in the chair.—Prof. Schoute continued his communication of October 29, on a general theorem in the theory of plane curves, and corrects a theorem of Laguerre.—Prof. Lorentz dealt with the relative motion of the earth and the luminiferous aether.—Prof. Kamerlingh Onnes spoke of measures on the relation of spark length and difference of potential made by Dr. Borgesius at Groningen with a double bifilar electrometer of his own construction. The differences hitherto found are explained by a correction for pressure and temperature having been omitted. Discharge between two concentric cylinders depends, as Gaugain stated, on the density of the inner one only. Provoking glow discharge on the inner one of two concentric cylinders proves successful in maintaining constant high potentials.

CONTENTS. PAGE

THURSDAY, JANUARY 5, 1893.

SCIENTIFIC WORTHIES.

XXVIII.—Sir Archibald Geikie.

SOME MONTHS ago the British Association for the Advancement of Science was holding its annual meeting at Edinburgh under the presidency of Sir Archibald Geikie, F.R.S., Director-General of the Geological Survey of the United Kingdom.

It may well be said that a more appropriate choice could hardly have been made by the Council of the learned Association. Not only is Sir Archibald a thorough Scot, born and educated in Scotland, where he fulfilled for many years the most important duties as a member of the geological staff, and later as a professor in the University of Edinburgh, but, having long been engaged in the supervision of the Scottish Survey, he mapped with his own hand many hundreds of square miles of country, and through the entire scenery of Scotland there is not a single point with the peculiarities of which he did not make himself thoroughly familiar. His knowledge of the ground is not at all restricted to geological relations. In Sir Archibald the qualities of the geologist are combined with those of the enthusiastic lover of landscape, and his able pencil excels in drawing original sketches in which the outlines, peculiar shades, and, one might say, the general spirit of the scenery are fixed with the most striking accuracy. Obviously, therefore, he was the right man to be placed at the head of the Edinburgh meeting, which many prominent foreign investigators attended in the hope of afterwards travelling, both as tourists and as men of science, through the most interesting fields of the Highlands. Nobody could have been better fitted to introduce them to the country. When putting Sir Archibald in the chair at Edinburgh, the British Association not only did due justice to one of the most distinguished sons of "modern Athens," it also took the best course to secure from foreign guests the fullest recognition of the various merits of Scotland.

Sir Archibald Geikie was born at Edinburgh in 1838. We learn from a notice in the *Mining Journal* that he was educated at the Royal High School and at the Edinburgh University. When he was only twenty years old he became an assistant on the Geological Survey for Scotland, and proved so able that in 1867, when the Scottish branch of the Survey was made a separate establishment, Sir Roderick Murchison deemed he could not do better than confer the directorial powers on the young assistant whom he had appreciated at work. Four years later, the chair of Geology and Mineralogy at the University having been founded by Sir Roderick with a concurrent endowment by the Crown, Archibald Geikie was invested with the new professorship, which he resigned only at the beginning of 1881, when he was appointed to succeed Sir Andrew C. Ramsay as Director-General of the Geological Survey of the United Kingdom, and Director of the Museum of Practical Geology in Jermyn Street.

That the new Director had not disappointed the hopes he had excited, appeared with sufficient clearness when, some time ago, the Queen conferred on him the honour of knighthood. Now it is our duty to note the chief features of his activity, and to state what personal part Sir Archibald Geikie has played in the recent progress of science. It is scarcely necessary to say that his geological achievements are too important to be conveniently reviewed in a few lines. Nevertheless we shall try to give a general idea of the prominent results to which his name must be attached.

Early appointed, as he was, as an officer of Scotland's Survey, he had, from the beginning, to deal with the most puzzling problems involved in the stratigraphy of the Highlands. The case was a very difficult one, and gave rise to much controversy between Sir Roderick Murchison and many other geologists, among whom it will be sufficient to quote the respected name of Nicol. As in the Highlands gneisses and ordinary crystalline schists were seen resting, with apparent conformity, on Silurian strata, it had been admitted by Murchison that the sequence was a normal one. Therefore the crystalline schists had to be regarded, in spite of their Archæan appearance, as metamorphosed Silurian deposits. Such an assumption had a considerable bearing on other geological problems, as it rendered highly probable the theory that the so-called primitive gneisses were altered sediments, and had nothing to do with the early crust of the molten globe.

That Sir Archibald should at first have taken his Director's side is not at all surprising. But he was never quite satisfied; and his love of truth led him, as soon as he was in a position to do so, to undertake a detailed review of the facts. Since the discovery of Silurian fossils in the rocks of N.W. Sutherland, it had been recognized that the key to the structure of the Scottish Highlands was to be searched for in that region. Accordingly, in the years 1883 and 1884, MM. Peach and Horne were entrusted with a careful study of the Durness and Eriboll districts. They were very far from being directed to obtain means of justifying the old survey. "It was a special injunction to the officers" (we quote Geikie's own words) "to divest themselves of any prepossession in favour of published views, and to map the actual facts in entire disregard of theory."

From the work ably carried on by the distinguished surveyors, and verified on the spot by the Director-General, it appeared clearly that Murchison had been deceived by prodigious terrestrial disturbances, of which, at the time, nobody could have formed an idea. Over immense reversed faults, termed *thrust planes* by Geikie and his officers, the older rocks on the upthrow side had been, as it were, pushed horizontally forward, covering much younger sediments; and the displacement attained the almost incredible distance of more than ten miles. Sometimes an outlier of the displaced ground was found capping a hill, while the remainder had been swept away by erosion, and the strangeness of the case led the observer to write, "One almost refuses to believe that the little outlier at the summit does not lie normally on the rocks below it, but on a nearly horizontal fault."

Disturbances of that kind had already been noticed in some coal-basins, as, for example, on the southern limit of the French and Belgian coal-field, where similar outliers had been termed by M. Gosselet "lambeaux de

poussée." But they occurred on a much smaller scale, and there was no reason why the phenomena should be considered otherwise than as quite exceptional. To recognize the generality of that class of stratigraphical accidents was a conquest of a high order, not only for Scottish geology, but for all countries where the work of orogenetic disturbances has for a long time suffered from the agencies of erosion. The Highlands of Scotland belong to that part of the old European continent which in earlier Palæozoic times emerged from the sea. Near the end of the Silurian period it was subjected to enormous pressure, which resulted in folding and breaking the whole border of the dry land, raising in the air a series of high mountainous ridges, the Caledonian chain of M. Suess. But millions of years have since passed over the land, and the continued action of atmospheric powers has left but a very small part of the original mass. It is extremely difficult, therefore, to restore the broken continuity; and through the quiet appearance of the now planed ground, the geologist is everywhere bound to search after the scattered signs of previous plication and fracture. This is now the task to be fulfilled by the detailed Survey, and every stratigraphical difficulty has to be treated in the newly-acquired light.

A few years after that discovery had been made in Scotland, Prof. Marcel Bertrand made in Southern France quite similar observations, showing that very limited patches of older formations, which had been till then regarded as remnants of ancient islets, projecting out of younger geological seas, were nothing else than outliers of reversed folds, the remainder of which had disappeared under the action of rain and rivers.

In this manner the correction of a long accepted error has led to stratigraphical conclusions of the highest import. In the meantime these gigantic displacements showed themselves accompanied by intense modifications of the rocks, so that Geikie was entitled to write: "In exchange for this abandoned belief, we are presented with startling new evidence of regional metamorphism on a colossal scale, and are admitted some way into the secret of the processes whereby it has been produced."

This is not the only occasion on which Sir Archibald has given proof of his readiness to admit frankly and decidedly the correction of opinions which have long been held. Some years ago, when the Lower Cambrian fauna had been detected by the officers of the Survey much below the Durness limestone of the Highlands, in a series of strata which rests unconformably on the Torridon sandstone, he was the first to announce the fact before the Geological Society. The "Precambrian," which he had till then been rather reluctant to recognize, has now taken its place in the scale of divisions. Moreover, he has created a new name, that of "Dalradian," for the long strip of Precambrian deposits which extends from Donegal to the centre and south-west of Scotland.

As one of the most characteristic formations in Scotland is the Old Red Sandstone, we cannot be surprised that Sir Archibald has devoted much care to the description of the peculiarities of that interesting group of strata. After a long and detailed study of the whole ground, he has summed up his views in some important memoirs, published in the Transactions of the Royal Society of Edinburgh. There he has called again to life the old and long-extinct lakes, where the grits and conglomerates of the Old Red were piled up through the disintegration of surrounding formations, namely, Lake Orcadie, Lake Caledonia, Lake Cheviot, Welsh Lake, and Lake of Lorne; each of them being a separate basin, where the work of sedimentation has been many times interrupted by volcanic outbursts, while in the adjacent and more quiet seas there were accumulated the marine deposits of Devonshire.

But the chief work of Sir Archibald seems to be his exhaustive review of the volcanic history of the British Isles. While his brother, Dr. James Geikie, the author of "The Great Ice Age," has done excellent service by deciphering the marks of former ice action on the soil of the United Kingdom, Sir Archibald has been particularly attracted by the work of fire, *i.e.* by the records of that volcanic activity, the evidence of which is so deeply impressed on the scenery of the Hebrides, of Wales, and other districts of Great Britain.

The British Isles are now a very quiet ground, where explosive activity and projection of stones seem to be restricted to electoral periods; and although Scotland has been from time to time shaken by minor earthquakes, no human eye has ever seen there any volcanic outburst. Nevertheless, during Tertiary times, immense sheets of lava were poured out in the north-west of the country. To discern the site of the centres of eruption, and determine the old chimneys, the remnants of which give a glimpse into the lowest parts of ascending lavas; to discriminate the volcanic *necks*, the intrusive sheets and dykes, the bedded lavas and the tuffs—this was the first part of the task undertaken by Sir Archibald. But it was not enough for him to re-ascend in the past to the beginning of the Tertiary period. Not only in the Old Red of Scotland, but in the very heart of the oldest formations known in England and Wales, there were numerous evidences of previous volcanic activity. To use Geikie's words: "Placed on the edge of a continent and the margin of a great ocean-basin, the site of Britain has lain along that critical border-zone where volcanic energy is more active and continuous."

The chief outlines of that marvellous story, which was hardly suspected some years ago, were recently traced in Geikie's presidential addresses to the Geological Society of London; a work which has been qualified by Mr. Iddings, the distinguished American petrographer, as "one of the most important contributions to the history of volcanic action." Nevertheless, it is only a preliminary paper, and in the same manner as he already has devoted a special memoir to the volcanic outbursts of Tertiary times, Sir Archibald promises to publish in a short time a detailed account of the Palæozoic eruptions.

In order to become competent for such an undertaking, the author had prepared himself without sparing time, labour, or trouble. Having travelled over much of Europe, from the north of Norway to the Lipari Islands, he was anxious to learn from personal observation the broad features of that American continent, the geological construction of which seems to have been conceived on a much larger scale than that of Europe. Therefore in 1878 he rambled over many hundreds of miles in Western America, from the Archæan fields of Canada to the huge volcanic plateaux of Oregon and

Idaho, where a country as large as France and Great Britain combined has been flooded with a continuous sheet of basalt. But stratigraphical studies were only part of the necessary initiation. Sir Archibald had been one of the first field-geologists in England to perceive the importance of microscopic investigation as an adjunct to field work. He might well have left the care of that special study to some officer in the Survey; but he wished to make himself master of the subject. Connected by personal friendship with Zirkel, Renard, and other eminent petrographers, he gave to that branch of the Survey such a vigorous impulse, that upwards of 5000 slices of British rocks were soon prepared and classed in the collections of the museum in Jermyn Street; and if he can now rely with full confidence on his distinguished professional officer, Mr. Harris Teall, for any determination of rocks, he himself has won all necessary competence in that department of science, which has been so much enlarged during the last twenty years.

An undertaking so ably provided for could not but prove successful. It is not, of course, our purpose to give an account of the results arrived at. The "History of Volcanic Action in the Area of the British Isles," as it was presented in the presidential addresses for the years 1891 and 1892, is so much condensed that it must be read *in extenso* by every one who takes interest in the matter. We would only call attention to the final summary, where some important and far-reaching conclusions are deduced from the observed facts. One of them is that British volcanoes have been active in sinking rather than in rising areas; to which it is added that the earlier eruptions of each period were generally more basic, while the later intrusions were more acid.

When presenting "a connected narrative of ascertained knowledge regarding the successive epochs of volcanic energy in this country," Sir Archibald did more than write an important chapter of British geology. It may be said that he definitively settled the long-controverted question, whether there has been any essential difference or not between the display of volcanic activity at various geological periods. Not very long ago some scientific schools—above all, on the Continent—showed the greatest reluctance to admit that true volcanoes could have existed during the Palæozoic era. When they were told of Cambrian lavas and felspathic ashes, of Silurian tuffs, especially of Precambrian felsites, they could not restrain a strong feeling of incredulity. Against old granitic or porphyritic eruptions they had nothing to object; but the volcanic *facies* appeared to them a privilege restricted to recent geological times. To this the present writer might bear personal testimony, as he found his "way of Damas" only when he was fortunate enough to ramble over North Wales, and gather with his own hands pieces of vesicular lava embedded in the tuffs of the Snowdon, or boulders of true felsite lying at the base of the Cambrian series at Llanberis.

Not only has Sir Archibald, in common with his countrymen, always escaped that kind of misconception, but he will have contributed more effectively than any other to place the matter in the true light. Thanks to the cliffs of Scotland, he has been able to trace the roots of old volcanoes, to show true volcanic bombs entombed in sediments, and to mark the site round which vast piles of lavas and tuffs, 5000 or 6000 feet in thickness, had been heaped up. Likewise, in his previous paper on Tertiary volcanoes, he had established by indisputable sketches that the granitic rocks of the islands of Mull and Skye were ejected during the earlier part of the Tertiary period, and that they belong to the central mass of intrusions, the lateral veins of which have taken the form of granophyres.

There is another kind of useful geological work which Sir Archibald has a right to be credited with; we allude to the restoration of the most friendly relations between the official Survey and the Geological Society of London. For many years those relations had been maintained at a rather low temperature; both independent geologists and Government's surveyors showed, as it were, more inclination to mutual and severe criticism than to brotherly co-operation. This period of misunderstanding is now well over. Thanks to the present Director, the Geological Society has more than once received the early flower of the capital results obtained by the Survey, and the recent Presidentship of Sir Archibald has solemnly sanctioned the return of a harmony which will prove of great benefit to the advancement of geological science in England.

This is a very brief and imperfect account of the chief work accomplished by the field-geologist, a work which would have been sufficient for the whole of a man's life. But we have now to consider in Sir Archibald the master who has been engaged in important educational duties. When he was appointed in 1871 to the chair of Geology at Edinburgh he had the whole work of that department to organize, a task which may be wearisome, but which involves great benefit for a man of labour, as he must face every difficulty, and obtain day by day a clear and personal idea of all that is required for teaching. To that we are indebted for the undisputed superiority which Sir Archibald has displayed in his "Text-book," as well as in his other educational writings, such as the "Class-Book," a very model of clearness, whereby it has been once more demonstrated that those only are qualified for writing elementary books, who are in the fullest possession of the whole matter. Likewise he is the author of small books or "primers" on physical geology and geography, of which some hundreds of thousands of copies have been sold, and which have been translated into most European languages as well as into some Asiatic tongues. This exceptional success will be easily understood if we remember that in Sir Archibald's works the traditional barrenness of geology is always smoothed and adorned by a deep and intense feeling for nature. Nobody has done more than he to associate geological science with the appreciation of scenery. In numberless writings he has undertaken to explain the origin of existing topographical features. Among others reference may be made to the volume on "The Scenery of Scotland viewed in connection with its Physical Geology," first published in 1869, of which a new edition appeared in 1887; also to "Geographical Evolution," in the Proceedings of the Royal Geographical Society for 1879; and "On the Origin of the Scenery of the British Isles," published in NATURE (vol. xxix. pp. 347, 396, 419, 442).

Nevertheless, whatever might have been the attainments of the geologist and of the teacher, they would not have been sufficient to secure universal recognition, had not Sir Archibald been provided in addition with the best powers as a writer. From the beginning he was strongly convinced of the importance of cultivating the literary element in scientific exposition, not only in order to make science interesting and intelligible to those outside the circle of actual workers, as he did in writing "Geological Sketches at Home and Abroad," but because he did not admit the right of a man of science to appear before the public without putting on the "nuptial dress." Every one who knows Sir Archibald will readily admit that in doing so he is not impelled by a desire for personal display. He is essentially a man of thought as well as of action. "*Res non verba*" might well serve him as mo tto, and whoever has seen his silent but piercing attention in listening to some scientific controversy would never be tempted to suspect him of a wish to search after resounding manifestations. But he has too much of the artist's temper to neglect correctness and elegance in the utterance of his thoughts. And since nothing in the world is less common than the union of scientific insight and acuteness with a vivid appreciation of nature and a delicate feeling for style, it is not strange that Sir Archibald's fame has passed far beyond the circle of professional men. The portrait will be duly completed when it is added that no one could have a better renown for frankness, fair dealing, and perfect trustworthiness in every relation of life.

It is highly gratifying for England that the recognition of such achievements has not been left to future times, and that the present generation has not failed in the duty of rewarding so much continuous and fruitful labour. He was admitted to the Roya Society before reaching the age of thirty, a most unusual honour; he has been Vice-President, and was recently elected Foreign Secretary, of that Society. Since 1890 an Associate of the Berlin Academy; elected by the Royal Society of Sciences at Göttingen, after the death of Studer, the Nestor of Swiss geologists; enrolled among the members of the Imperial Leopold-Caroline German Academy, of the Imp erial Society of Naturalists of Moscow, &c., &c., he was chosen in 1891 as a corresponden t by the French Academy of Sciences, and in the same year he was made a knight. An honorary LL.D. of the Universities of St. Andrews and Edinburgh, he has received the Murchison medal of the Geological Society of London, and twice the MacDougal Brisbane Gold Medal of the Royal Society of Edinburgh has been conferred on him, in recognition of the zeal and skill displayed in explaining the geological peculiarities of his mother-land. He is now at the summit of his career, and not so heavily laden with years but that we may express for him the wish *ad multos annos*. Let us hope that he will long remain at the head of the distinguished staff to which he has given so profitable an impulse, and continue to serve as a comforting example for those who refuse to acknowledge any other means of genuine success than constant labour and faithfulness to duty.

A. DE LAPPARENT.

SHAKING THE FOUNDATIONS OF SCIENCE.[1]

TO judge by the columns of the daily press, we must expect to find a large number of enterprising company-promoters coming forward shortly to urge, in Parliament and elsewhere, that leave may be given them to confer lasting benefits upon Londoners. The good they propose to do comes in the shape of underground intercommunication. Locomotives of the ordinary construction, it would seem, are not to be employed, but instead of them cable traction or electric energy in some shape or another. On these points, however, we must speak with caution, for we are told that an absence of definite statements and programmes is one of the main features of the pronouncements so far issued.

On two previous occasions it has been our duty to draw attention to a scheme, intended to provide more ready means of intercommunication between different parts of London, which threatens to inflict serious damage upon the property of the nation.

It so happens that one of the schemes to which reference was made in the opening paragraph is a rehabilitation and expansion of that very project against which we protested on the previous occasion. The attempt, which has already once been thwarted, to render the study of the sciences involving exact measurement impossible at South Kensington, is again to be repeated, and it is necessary to warn the public that an enterprise undertaken nominally for their interests, which are, or the moment, regarded as identical with those of the company-promoter, will strike a fatal blow at the utility of institutions on which many thousands of pounds of money, public and other, have already been spent, and on which it is in contemplation to spend many thousands more. Our protest on the former occasion was based on scientific grounds. There were others strongly urged from other points of view, and as a result of the opposition the scheme was withdrawn for a time.

In the shape it now assumes it is still more objectionable, as the scope is now a more ambitious one.

Our objection was simply to the route to be followed. In London we have only one locality where telescopes are nightly used by teachers and students; we have only one institution the function of which is limited to physical and chemical teaching and research, where delicate measurements are essential, and form part of the routine work; we have only one institution, the function of which is to teach applied science in the most efficient manner—that is, by teaching in which experiment and observation, and of extreme delicacy, must go hand in hand with the *viva voce* exposition of the professor of each branch of applied science.

The contemplated railway proposes to sweep all these away. Astronomical Observatories, the various Laboratories of the Royal College of Science, and of the City and Guilds Institute, are not to be considered the least in the world. This is practically what it comes to; for we doubt whether either teacher or taught will care to remain in a locality where neither valid experiments nor observations are possible.

[1] Continued from vol. xliii. p. 146.

We need not waste time in considering whether some means could not be found to continue to take astronomical photographs of say an hour's exposure, or to use chemical balances of the greatest delicacy, with a railway or tramway of any kind running intermittently within twenty yards of the laboratory in which the work is supposed to be carried on; and it is also clear that the result would be disastrous if the traffic were carried on at any practicable depth.

Last year a joint Committee of the Houses of Lords and Commons fully considered the question as to the principles on which future extensions of what may be called omnibus traffic should be carried on, and they came to the conclusion that electric and cable railways constructed at a considerable depth below the surface would probably be the most convenient means for uniting the various parts of the metropolis more closely.

Some people have attempted to read into this part of the Committee's report that given a cable or electric railway *there will be no shaking!* And it has been suggested that all such opposition as we have expressed above should disappear. This of course is the view of the company-promoter, but it will commend itself to no one else. In fact there are special objections to an electric railway in addition to those earthquakes more or less mitigated which are associated with any system of traction.

No evidence was laid before the Committee as to some of the disadvantages which are incidental to the use of electricity. It is true that these disadvantages are not such as to interfere with the further extension of electrical railways, but they are of sufficient importance to be considered in deciding on the routes which the railways shall follow. Experiments made some little time ago in the neighbourhood of the South London Electrical Railway proved that the electrical disturbances were so great that it was doubtful whether ordinary higher students' work could be carried on within a quarter of a mile.

A quarter of a mile! And the proposed railway, or electric way, or cable way, or tramway is to run within twenty yards of electrical and magnetic laboratories. "*Rien n'est sacré pour un sapeur!*" an evil hidden in the ground ceases to be one.

It must not be forgotten that the interests at stake are not only those of the higher sciences and research. It might, perhaps, be argued that as the instruments used for investigation become more sensitive, and as the necessity for accuracy increases, it may be necessary that researches of a special character should be carried out in places specially selected for their freedom from all external disturbance. A serious damage will, however, be done to our large towns if it becomes necessary for every middle-class youth who wants to master more than the elements of science to become a boarder at a country college. It is frequently complained that there is an increasing separation between class and class, those who are able to do so leaving the towns for the more distant suburbs. It would be a thousand pities if the higher education were also, even in part, to be banished from our great centres of population.

It may be urged by the promoters of the company that it will be easy for them or the Government to plant the Royal College of Science elsewhere, but if the buildings of the College are notoriously inadequate, it was clearly stated at the time when the proposal to place a collection of pictures on the site reserved for science made it necessary to explain the future policy of the Department of Science and Art, that the collections and the laboratories attached to them were in the future to be housed on the plot close to the present site.

But as stated before, it is not necessary only to base our case upon the injury which would certainly be done to the Royal College of Science; it must be remembered that hard by is the City and Guilds Central Institution, in which extensive and costly laboratories, built by the munificence of the City Companies, have during the last few years been filled with students, many of whom are engaged in advanced studies.

Every argument which applies to the one case holds good in the other. The work of the City Companies and the interests of these institutions are endangered in the same way, and for the same reasons, as those of the Government College over the way.

On the previous occasion, when it was proposed to bring a railway at the back of the Central Institution, the Professors there, with the sanction of the City and Guilds of London Institute, opposed the scheme. We understand that the Professors have again made a representation to the Institute which in all probability will result in steps being taken to prevent the construction of any railway or tramway which would interfere with the work carried out in the Physical Department of the Central Institution.

In both these institutions it is as important that the apparatus should be used without let or hindrance from external disturbances, as say, that the reading-room in the British Museum should not be rendered uninhabitable by a nuisance produced either by private individuals or by some company in the neighbourhood.

On these grounds we protest in the name of science against a railway of any kind in Exhibition Road.

If there is one district in the metropolis which ought to be thus secured, it is the neighbourhood of the great national scientific school and its associated collections.

And here a word about these Science Collections. There are philistines among us who think that the collections would do very well without the schools, as the schools could do very well without either higher teaching or research.

There is no doubt a certain advantage to be gained by collecting types of all sorts of apparatus, exhibiting them appropriately labelled in glass cases, through which the public may gaze with, it is to be feared, somewhat indiscriminate admiration; but it must always be recollected that the nation is proud of the British Museum and Art Galleries, not merely because they play a useful part in educating the crowds who visit them, but also because they are centres to which students resort from all parts, not only of the United Kingdom, but of the civilized world, not to gaze at the collections but to *use* them. In like manner a national collection of scientific apparatus should be brought together, not merely to be stared at, but to be used. By an arrangement more logical than those to which our haphazard English

customs too frequently lead, this second object is at present attained.

It is almost ludicrous that at the very moment when a Royal Commission is sitting to determine the constitution of a new University for London, Parliament should be asked to sanction a Bill which, if it serves as a precedent, may make the teaching of some of the most important sciences impossible within the metropolitan area. Indeed, in this danger we find a new confirmation of the importance of the policy which we have often urged upon those who are directly interested in the constitution of the future University.

Science teaching in Exhibition Road is threatened to-day. It may be threatened somewhere else to-morrow. It will be impossible for a number of competing colleges to defeat the railway engineers, or to preserve intact for scientific research a number of buildings planted upon sites selected without reference to the new danger which has arisen. They will be attacked in detail, and beaten one by one. How immensely in this, as in many other matters, would their position be strengthened if they were able to speak with one voice in support of a plan decided on in common, and defended together. If the hoped-for University of the future already existed; if it spoke with the prestige of the existing University of London, combined with that of the consolidated teaching staffs of the London Colleges; if the support of a Government Department could be asked to aid a University which, like the British Museum, commanded universal respect and support; then it might be possible to obtain a ready hearing for opinions given with all the weight of a great institution of which the country would be justly proud. Till the union is effected, which alone will make science in London able to meet its enemies in the gate, we must struggle as best we can to prevent irreparable mischief.

We can only hope that the Vice-President of the Council, who is known to have the interests of the higher education at heart, will not allow a railway, electrical or other, to injure the teaching institutions clustered round the magnificent collections of apparatus in his charge.

SOUND AND MUSIC.

Sound and Music. By the Rev. J. A. Zahm, C.S.C., Professor of Physics in the University of Notre Dame. Large octavo, 452 pages. (Chicago: A. C. McClurg and Company, 1892.)

THIS handsomely got-up and lavishly illustrated volume is, the author informs us, a largely expanded transcript of a course of lectures delivered by him, in 1891 "in the Catholic University of America, at Washington, D.C." Its "main purpose is to give musicians and general readers an exact knowledge, based on experiment, of the principles of acoustics, and to present at the same time a brief exposition of the physical basis of musical harmony." A clear intimation is given at the outset (p. 18) of the predominant *rôle* which experiment is to play in the acoustical portion of the undertaking. Had Prof. Zahm not had at his disposal "all the more delicate and important instruments" of research and verification, in the theory of sound, constructed by Dr. Koenig of Paris, he would "not have attempted to give the present lectures on sound" before such an audience as that which actually attended them. With Dr. Koenig's apparatus around him, however, he had assured means of "entertaining" his hearers, and of "illustrating in a way that would otherwise be impossible the most salient facts and phenomena of sound." The late Isaac Todhunter has deprecated the systematic repetition of perfectly established experiments, on the ground that their results ought to be believed on the statements of a tutor—"probably a clergyman of mature knowledge, recognised ability, and blameless character"—to suspect whom was in itself irrational.[1] Prof. Zahm's practice pushes to a great length a view directly opposed to that enunciated—with obvious humorous exaggeration—by the well-known Cambridge private tutor. Not content with a single experiment decisive of each successive issue presented, he performs a whole series bringing into action all the resources of his superbly found collection of acoustical apparatus. It is no detraction from the clear and interesting manner in which these formidably numerous experiments are set forth, to say that the amount of space necessarily devoted to explaining the mechanism of the apparatus used gives to parts of Prof. Zahm's volume somewhat of the look of an acoustical instrument-maker's illustrated catalogue. Subject, however, to this defect, if defect it be, the lectures are decidedly pleasant and attractive reading. The illustrations, too, are thoroughly clear and beautifully executed, so that our author may be fairly congratulated on success in 'entertaining'—the word is his own—his hearers and readers. His object, to give to general readers an "exact knowledge" of the principles of acoustics, has also been in a fair measure attained, but subject to certain not inconsiderable deductions. In describing the processes and results of experiment Prof. Zahm is clear and thoroughgoing: in expounding the parts of acoustical theory which must be mastered if the facts thus obtained are to be understood in their mutual relations, he is often vague and superficial. Thus the nature of wave-motion, the formation of stationary undulations, the composition of small vibratory movements—matters of crucial importance to any connected comprehension of Acoustics—receive from him no effective elucidation. Nay, he is even chargeable with having, by the misuse of a technical term of perfectly settled meaning, written in a way likely to confuse his readers' ideas on these very matters. On p. 46 he calls certain points in a series of progressive waves "NODAL points where there is no motion," thus confusing two things which ought to be most carefully distinguished from each other, a point of *momentary* rest in a *progressive wave*, and one of *permanent* rest in a *stationary undulation*. The usage which restricts 'node' to this latter meaning is so well established that such use of it as the above is quite inexcusable, especially in an author who himself elsewhere, p. 146 &c., employs it in its ordinary signification. The same indifference to accuracy of expression recurs in this volume with a frequency not creditable to a professor of an exact science. Thus on p. 50 the return movement of a prong of a tuning fork is said

[1] "The Conflict of Studies," p. 17.

to 'pull' air particles apart. On p. 52 we are told that the motions of particles of a water wave "are always at right angles to the direction of the wave itself." On p. 68 the author corrects this statement, but in doing so, takes occasion to speak of a plane "in," instead of 'passing through' the line of progression. On p. 380 he describes harmonic partial-tones as "modifying the quality of their fundamental," though he obviously means the quality of the compound sound due to the fundamental and other partial-tones combined. On p. 387 it is said that the "ratios of frequencies" which characterize particular sounds "are called intervals," and that by dividing one note by another we obtain the intervals between them. Language of this kind is, indeed, hardly misleading, but it is certainly very slipshod.

Before passing from the more generally acoustical, to the more specially musical portion of Prof. Zahm's volume, it is proper to point out one important respect in which it has the advantage over most, or possibly all, the manuals on the same subject which have preceded it. This merit consists in giving a somewhat full account of elaborate experimental researches on beats, combination-tones and quality conducted by Dr. Koenig, the results of which are to a considerable extent at variance with conclusions previously announced by Prof. Helmholtz. In the opinion of our author, Dr. Koenig is "one who, not excepting even the eminent German philosopher just mentioned (Helmholtz), has contributed more than any other person to the advancement of the science of acoustics" (p. 17). A more balanced judgment, while placing great reliance on Dr. Koenig's experimental skill and on the superlative excellence of the apparatus constructed by him, would probably attribute to Helmholtz's opinion a preponderant weight in interpreting and correlating the results of experiment. Be that, however, as it may, Prof. Zahm has done excellent service by popularizing the work so laboriously performed, and so modestly placed on record, by the eminent instrument-maker to whom no one who has put his hand to acoustical work can fail to be under considerable practical obligations.

The specifically musical are decidedly the least meritorious parts of our author's performance. The looseness of phraseology already complained of is here at its worst. On p. 166 we are told that a 'comma,' ($\frac{81}{80}$) is "the smallest interval used in music." A beginner might easily take this to mean that notes differing by only that interval were actually heard consecutively in a musical phrase—of course an absurd supposition. Very misleading, again, is the statement on p. 388 that tones, like major and minor tones, that differ from each other only by a comma "are considered in music to have the same value." The only rational meaning to be got out of it seems to be that *in the equally tempered scale* the distinction between major and minor tones is obliterated On p. 389 the notes of the diatonic scale, and their relations, in respect to rapidity of vibration "to one another," are set out, and it is added that all but the second and the seventh of the intervals thus indicated are consonant. The essential piece of information, that it is not the intervals formed by these notes with "one another," but with *the tonic*, that are in question, is withheld, and so the reader is left free to suppose *e.g.* that the tritone, F—B, is a consonance. On p. 390 the 'inversion' of intervals is mentioned without any explanation of its meaning.

Attention may well be called to a process of reasoning which occurs on pp. 388–390. Prof. Zahm abruptly introduces (p. 388) calculation by "frequency-ratios"; assumes, without attempt at proof, that addition of two semitones is performed by squaring the ratio $\frac{16}{15}$, and then remarks (p. 390) "From the foregoing we observe that the sum of two intervals is obtained by multiplying, not by adding their ratios together." An *assumption* in a *particular case* is thus made to do duty as a *general demonstration.*

On p. 396 we read that "so perfectly does the interval of the fifth answer the requirements of the ear that even unpractised singers find it quite natural to take a fifth to a chorus that does not quite suit the pitch of their voice." If, as this passage appears to suggest, practised singers in America find it still more natural to accompany melodies in consecutive fifths, wonderful effects may surely be expected from the choruses to be heard at the Chicago exhibition.

On p. 429 our author describes a diagram by Helmholtz as concerned with the transposition of an interval by an octave, whereas what it really deals with is the enlargement of the interval in question by the addition to it of an octave. On p. 430 he writes down, *as constituents of the chromatic scale of C*, the notes E♯, F♭, B♯ and C♭.

On p. 441, he tells us that in listening to such violin players as Joachim, Wilhelmj, and others "one can always hear distinctly the *Tartini*, or beat-tones, that add such richness and volume to violin music."

To gauge the amount of truth contained in this remark it suffices to bear in mind that in the case of most major, and of all minor consonant chords, Tartini's tones cause a *decided dissonance.* Players who made them 'always distinctly audible' would soon be reduced to permanent inaudibility themselves.

Prof. Zahm's volume is creditably free from misprints: the following have, however, been noted:

P. 23, l. 16 'period' for 'periods.'
P. 68, l. 21 'amplitude' for 'amplitudes.'
P. 90, l. 8 'Ajugari' for 'Agujari.'
P. 142, in diagram, B_4♯ for B_4.
P. 152, in diagram I, B♯ for B.
P. 388, ll. 11 and 12, G for F.

GERLAND'S ETHNOLOGICAL ATLAS.

Atlas der Völkerkunde. (Berghaus' Physikalischer Atlas, Abth. vii.). Bearbeitet von Dr. Georg Gerland, Professor a.d. Universität in Strassburg. (Gotha: Perthes, 1892.)

ANTHROPOLOGY owes much to Prof. Gerland, whose completion of the two last volumes of the late Prof. Waitz's "Anthropologie der Naturvölker" is a monument of that co-ordinated knowledge of fact which is the source of sound principle. His new "Atlas of Ethnology," while forming part of the great Physical Atlas of Berghaus, may be obtained and used as a separate work by anthro-

pologists, to whom it will be of great service in methodizing the vast and growing information with which they have to deal. This application of graphical method, it is true, has difficulties which even the greatest skill cannot altogether overcome, but Prof. Gerland may well be content with his success in making evident at a glance the characteristics of mankind, seen from many points of view. Their distribution over the earth, as thus made evident, may often lead straight on into theories of origin. The fifteen plates contain nearly fifty maps, each suggesting a principle, or showing where there is room for one.

Plate I. represents on two planiglobes the classification of human races as to skin and hair. Prof. Gerland does not even combine these two characteristics, and points out in his introductory remarks that any attempt to map out man into defined physical races is impossible, for such division does not exist in nature. Anthropologists of course know this, but care is not always taken to make it clear that race-types are not so much complete realities as statistical abstractions from partial realities, the various measurable characters of skull, limbs, complexion, hair-form, &c., combining and blending too intricately for absolute definition. I was struck by meeting lately in a popular book with a confident mention of the four distinct Aryan race-types, and it occurred to me that it would bring the statement down to its bearings to put one of Prof. Gerland's planiglobes before the author, desiring him to define and map out these varieties of mankind. Even in Gerland's broad general distinctions of complexion and hair, an anthropologist not thoroughly special on the anatomical side may find novelty and difficulty. The opinion that all native Americans are similar as to race is here strongly and probably with reason modified by the native Brazilians being separated on the complexion-map from other peoples of North and South America, and placed to match the Tartars and Chinese. What amount of evidence there is for placing the Berbers of North Africa under the same map-colour seems not so clear, but it is to be noticed that the same tint includes several more or less distinct grades in Broca's scale. An attempt is even made to separate the friz-haired negroids into classes according to the arrangement of their corkscrew-tufts of hair on the skin. Plate III., in two maps, classifies man according to his religious beliefs and customs, and here the prevalence of special rites offers instructive generalizations. Thus the American line which limits the smoking of tobacco as a religious ceremony, indicates the spread of this peculiar rite from some religious centre over an enormous area. No doubt it is rooted in nature, from the fact that its narcotic ecstasy brought the priest into direct visionary contact with the spirit-world. But none the less, it proves the religions of savage tribes, separated by great distances on the map, to be bound together by historical connexion. Not less remarkable is the compactness of the districts of Eastern Asia and the opposite Continent of America, where masks are used, apparently originally with religious significance Here again it is evident that we have to do not merely with independent growth from the human mind, but in some way with historical transmission. It must be remembered in using these maps, that they bind their author only to fact, and not to theoretical interpretation. This same plate maps out the immense districts whose natives have a myth of a deluge, the upheaving of the earth, &c., but it cannot distinguish in North and South America, for instance, between regions where deluge-myths are old, and those where they were introduced by the Jesuits a few generations ago. Plate IV., mapping out regions liable to special diseases, as malarious fevers, pestilence, cholera, yaws, &c., contains in a condensed form a vast collection of knowledge, bearing on anthropological arguments as to the relation of race to physical constitution, and thus opening into one of the great problems of the history of man. Plate V. classes out the varieties of human food, clothing, dwellings and occupations. Plate VI. and onward map out the distribution of nations and tribes at different periods as known to history, Plate XIV. being devoted to the distribution of languages over the world.

Anthropologists who keep this atlas at hand as a help in their work will by practice find out its merits and defects. The representation of the geographical distribution of arts and customs has long been a feature of the Pitt-Rivers Museum, where so far as possible each series, illustrating development and transmission of culture, is accompanied by a small world-map coloured to show the parts of the world it occupies. It is of course impossible to Prof. Gerland to work in such detail, involving as it would do hundreds of separate charts. He has to indicate his distributions on a moderate number of plates and mostly uses planiglobes, a projection which, after being neglected for generations, will, in its improved modern arrangement, certainly come into more general favour. On these, by ingenious devices of tinted patches and streaks, combined with lines and dots, he succeeds in giving a more general survey of man and civilization than our students have ever had in their hands before. EDWARD B. TYLOR.

OUR BOOK SHELF.

Castorologia; or, The History and Traditions of the Canadian Beaver. By Horace Martin, F.Z.S. (London: Stanford, 1892.)

"BEAVER" was once the most important fur in the world. In former days the pelt of this Rodent was the standard by which all barter in the Dominion of Canada was regulated, and "beaver" passed as current coin throughout the whole of North America. Even now the quantity of beaver skins brought to England is considerable. Mr. Poland, in his "Fur-bearing Animals," tells us that upwards of 63,000 beaver skins were sold by the Hudson's Bay Company in 1891. But "beaver-hats" formerly required a much larger supply than this, and in 1743 it is said that 127,000 beaver-skins were imported into La Rochelle alone. Our "top" hats are now made of silk, and beaver has become a fur of second-rate importance.

Besides the fur of the beaver many other points of interest attached to this animal will be found discussed more or less completely in Mr. Martin's volume. Long before its fur was required for hats *castoreum* or castorin—a substance found in two large glands, situated near the base of the beaver's tail—was a much-valued specific in medicine, as spoken of by Hippocrates and Pliny. Even at the present time its use is by no means abandoned, and the "crude article" is "still sold at our drug-stores" at prices varying "from eight to ten dollars a

pound." But in past centuries castoreum was considered a sovereign remedy for every kind of disease. Many amusing details on this part of the subject are given by Mr. Martin, mostly extracted from the "Castorologia" of Johannes Francus, published in 1685. The wisdom of Solomon himself is attributed by this learned author to the virtues of the beaver. To acquire it, it is only necessary "to wear a hat of beaver's skin, to rub the head and spine with that animal's oil, and to take twice a year the weight of a gold crown piece of castoreum."

At the end of his volume Mr. Martin places a short account by Mr. C. V. Riley, the well-known American entomologist, of *Platypsillus castoris*, a parasite on the beaver, and one of the most remarkable among the many extraordinary forms of parasitic insects. Mr. Riley correctly refers this creature to the coleoptera, although other naturalists, and, amongst others, its discoverer, Ritsema, have expressed different views on this point He omits, however, to refer to the excellent account of *Platypsillus castoris*, written by the late John Leconte, and published in the Proceedings of the Zoological Society of London for 1872. Dr. Leconte has here shown that it is necessary to make a special family (Platypsillidæ) for the reception of this curious parasite, but that it must be unquestionably referred to the coleoptera.

On account of these and other peculiarities the beaver is unquestionably an animal of great general interest, and Mr. Martin has done well to devote a volume to what is evidently his favourite theme. There is, we must allow, little, if anything, original in it, and the statements on scientific points cannot always be implicitly depended upon. But the author has brought together a large amount of information on the subject, and his book is "popularly written" and "fully illustrated," though we cannot quite agree to his claims to have produced an "exhaustive monograph."

An Atlas of Astronomy. By Sir Robert Stawell Ball, LL.D., F.R.S. (London: George Philip and Son, 1892.)

A NEW book by Sir Robert Ball is always a matter of interest, but the present one naturally lacks the usual characteristics. It is described as "a series of 72 plates with introduction and index." In addition to monthly and general maps of the stars, the atlas reproduces pictures of the sun, moon, planets, and comets, and contains diagrams illustrating their motions and dimensions. As the book is chiefly meant to be a companion to more general works, the introductory matter is purposely brief, but still it has several features of interest. Special attention may be drawn to the excellent description of a simple graphical method of determining the orbit of a binary star.

To the serious student who may possess a small telescope the new atlas will be very useful. Here he may learn how to determine the positions of sun spots, how to find the places occupied by the various planets, and what objects are most likely to be within reach of his instrument. Those interested in selenography will derive much assistance from the twelve plates showing the moon at different phases, which have been specially drawn by Mr. Eger, each being accompanied by an index map. One can only wonder, however, that some of the recent excellent photographs of the moon have not been pressed into the service.

The star maps, on the whole, are excellent, and our only complaint is of the excessive density of the Milky Way, which, in some parts of the maps, is almost sufficient to obliterate the names and numbers of the stars. The monthly maps will be particularly useful to those who are just learning the constellations, a new feature being a belt indicating the track of the planets.

Spectroscopic astronomy is entirely omitted, the author being of opinion that this great branch of work can only receive justice in a separate atlas. In this we heartily agree, and trust that such an atlas will soon be forthcoming.

The author's large following of readers will no doubt welcome the new comer, but we must express regret that astronomical photographs are not more fully represented. It would be interesting, for example, to reproduce a series of photographs of typical nebulæ, all of which, we believe, are now available. A plate showing the advantages of photography in the delineation of stars would also add to the interest of the atlas.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Vector Analysis.

I FANCIED that, in reply to the voluminous letters of Prof. Willard Gibbs (NATURE, xliii. 511; xliv. 79), I had said in a few words all that is requisite (if, indeed anything *be* requisite) to show the necessary impotence, as well as the inevitable unwieldiness, of every system of (so-called) *Vector Analysis* which does not recognize as its most important feature the product (or the quotient) of two vectors:—*i.e.* a Quaternion.

A recent perusal of the first four pages of a memoir by Mr. O. Heaviside (*Phil. Trans.* 1892):—for so far only could I go:—has dispelled the illusion. For he calls the correspondence just spoken of a "rather one-sided discussion":—a truly Delphic delivery:—cleared up, however, by what follows it. I particularly desired to read the memoir (which the Author had kindly sent me) as I hoped to learn from it something new in Electrodynamics. But, on the fifth page, I met the check-taker as it were:—and found that I must pay before I could go further. I found that I should not only have to unlearn Quaternions (in whose disfavour much is said) but also to learn a new and most uncouth parody of notations long familiar to me; so I had to relinquish the attempt. In the last of the four pages of my progress, I had found that Mr. Heaviside (though, as above stated, he has a system of his own) is an admirer of Prof. Gibbs' system, to such an extent at least that he thinks "his treatment of the linear vector operator specially deserving of notice." There I was content to leave the matter.

But Mr. Heaviside has just published (*Electrician*, 9/12/92) an elaborate attack on Quaternions, of a kind which is calculated to do real injury to beginners. In answer to his remarks, in which he continues to point to me as the persistent advocate of a system which all right-minded physicists should avoid, I would simply refer him (and his readers, if there be such) to a brief Address which I gave a short time ago to the Physical Society of Edinburgh University (*Phil. Mag.* Jan. 1890). One or two sentences, alone, I will quote here:—

"if we can find a language which secures, to an unparalleled extent, compactness and elegance, and at the same time is transcendently expressive—bearing its full meaning on its face—it is surely foolish, at least, not to make habitual use of it."

"For (Hamilton) the most complex trains of formulæ, of the most artificial kind, had no secrets:—he was one of the very few who could afford to dispense with simplifications: yet, when he had tried quaternions, he threw over all other methods in their favour, devoting almost exclusively to their development the last twenty years of an exceedingly active life."

The main object, however, of my present letter, is to call attention to a paper by Dr. Knott, recently read before the Royal Society of Edinburgh. Dr. Knott has actually had the courage to *read* the pamphlets of Gibbs and Heaviside; and, after an arduous journey through these trackless jungles, has emerged a more resolute supporter of Quaternions than when he entered. He has revealed the (from me at least) hitherto hidden mysteries of the Dyadic, and of Prof. Gibbs' strange symbols Pot, Lap, Max, New, &c. The first turns out to be only the linear and vector function; and the others are merely more or less distressing symptoms characteristic of imperfect digestion or assimilation of ∇. And when, at my request, Dr. Knott

translated into intelligible form the various terms of one of the less formidable formulæ of Mr. Heaviside's memoir, I was surprized to find two old and very unpretending friends masquerading in one person like a pantomime Blunderbore. In one of his Avatars the monster contains, besides the enclosing brackets, no fewer than 24 letters, 12 suffixes, 3 points, and 5 signs! When he next appears he has still the brackets to hold him together, but although he has now only 18 letters, he makes up his full tale of 44 (or 46) symbols; for he has 9 suffixes, 3 indices, 3 points, 5 signs, and 3 *pairs* of parentheses! I used to know him as compounded of 14 separate marks only, viz.:— $V^2\nabla\sigma + 2S\nabla\nabla_1 S\sigma\sigma_1$:—but, unless I had required to dissect him, I should never have put him in anything resembling his new guise.

Dr. Knott's paper is, throughout, interesting and instructive:—it is a complete exposure of the pretensions and defects of the (so-called) Vector Systems. "Wer diesen Schleier hebt soll Wahrheit schauen!" I find it difficult to decide whether the impression its revelations have left on me is that of mere amused disappointment, or of mingled astonishment and pity.

P. G. TAIT.

Edinburgh, 24/12/92.

Measurement of Distances of Binary Stars.

WITH reference to Mr. C. E. Stromeyer's letter on the above subject, which appeared on p. 199, it may be of interest to point out that his plan of determining the distance of a binary star is by no means a new one.

The method was, I think, first suggested by Mr. Fox Talbot at the Edinburgh meeting of the British Association in 1871; but the mere idea was sufficiently obvious as soon as the possibility of determining velocities by the spectroscope had been demonstrated by Dr. Huggins.

The first discussion of the geometrical conditions of the problem was given by Prof. C. Niven in the *Monthly Notices*, vol. xxxiv. No. 7, where he exhibits the relation connecting the parallax, the relative velocity, and the elements of the orbit of a double star, and computes the value of the product (πV) of the parallax and velocity for a small number of binary systems.

In a paper published in the Proceedings of the Royal Irish Academy for May, 1886, I examined the same question from a slightly different point of view, being at the time unaware of Prof. Niven's paper, and was led to similar results. An epitome of this paper was published in your Astronomical Column, vol. xxxiv. p. 206. From the results obtained it appeared that, all things considered, γ-Coronæ Australis and α-Centauri were the most likely binaries to yield to this method of eliciting the secret of their parallax, while α-Geminorum, one of the stars selected by Mr. Stromeyer, was shown to be most unfavourable on account of the situation of its orbit.

In the *Monthly Notices* for March, 1890, I again drew attention to the subject in view of the accuracy of the results obtained by the photographic method in the hands of Prof. Pickering and Prof. Vogel. In this paper I gave an extended list of binaries with the usual geometrical and dynamical elements, and in addition the two elements A and B on which the relative velocity depends. I also gave the greatest value which πV can attain in each case and the velocity to be expected in the case of those stars whose parallaxes had been determined.

Again in Mr. J. E. Gore's valuable catalogue of Binary Star Orbits, published in the Proceedings of the Royal Irish Academy for June, 1890, columns 18 and 19 are devoted to the constants A and B computed from my formulæ (which I may say ought more properly to be called Prof. Niven's formulæ on account of the priority of his paper) for eighty-one different orbits.

The subject has also been discussed by Miss Clerke in "The System of the Stars," pp. 199–201, where references to most of the original publications will be found.

I may perhaps add that the inverse problem of determining the elements of the orbit from spectroscopic observations alone has also been investigated by me in the *Monthly Notices*, vol. li. No. 5, where I have deduced the principal elements of the orbit of β-Aurigæ, a spectroscopic double which no telescope can divide.

I have been disappointed that astronomers engaged on spectroscopic determinations of stellar velocities have not devoted more attention to observations of already known binaries, which appear to me to offer a promising field of work, and have often regretted that at this observatory we have not the means of undertaking the investigation, and if Mr. Stromeyer's letter has no other effect than to bring the subject once more forward it will have done good service, but I should like to point out that the second of the stars selected by him ought on no account to be taken as a test of the feasibility of the method, since the accurate discussion of the conditions shows that unless this is an exceptionally remote system the velocity must be very small indeed. For instance, assuming Johnson's parallax, viz. 0″·20, the relative velocity of the components amounted last year to only 0·6 miles per second.

In the northern hemisphere the most favourably situated binaries are 70 Ophiuchi, ξ-Ursæ Majoris, and, if Peters' orbit represents the real motion of the pair, 61 Cygni; while for the southern hemisphere special attention ought to be directed to α-Centauri and γ-Coronæ Australis.

In Mr. Gore's Catalogue, referred to above, will be found all the materials for determining when to observe any known binary most favourably in this respect, and for deducing its parallax from the measures obtained, and it ought to be borne in mind before letting the subject sink back once more into oblivion, that, other things being equal, this method is most likely to succeed in the case of the most distant systems, where the parallax is so small that the ordinary trigonometrical method necessarily fails us, and that when the micrometer, the heliometer, and the stellar photograph break down, the spectroscope will sound the further depths with ever-increasing facility.

Dunsink Observatory, co. Dublin. ARTHUR A. RAMBAUT.
December 30.

December Meteors (Geminids).

THESE meteors were moderately abundant on the night of December 12, which appears to have been a very favourable one in regard to weather. The chief radiant point was observed in the normal position very close to α Geminorum, and there was a strong contemporary shower from a centre east of β Geminorum.

At 10h. 10m. December 12, a fireball estimated to be twice as brilliant as Venus was observed by Mr. Booth at Leeds. It moved rather slowly from $150° + 43°$ to $188° + 41°$, and divided into two pieces at the finish.

Mr. Wm. Burrows, of Small Lane, Ormskirk, writes to me with reference to a meteorite which he observed to fall at a later hour on the same night. He says the time was 6.52 a.m. (December 13), and refers to the phenomenon as follows:— "Seeing the meteor was coming to the earth I crossed the road to where it appeared to be falling, and it fell about two yards from me. When it struck the earth it made a noise like the report of a gun; it also went black instantly. While descending it had a tail of fire about a foot long. It is $1\frac{3}{8}$ inch in diameter one way, and $1\frac{1}{4}$ inch another, and one inch thick."

Mr. Burrows sends drawings of the object, and it being still in his possession it is hoped the matter may be suitably investigated. Should it prove a veritable meteorite one interesting circumstance in connection with it will be that its descent took place concurrently with the shower of Geminids.

It is significant that December 9–13 constitutes a well-defined ærolitic epoch, rendered memorable by the fall at Wold Cottage, Thwing, Yorkshire, on December 13, 1795, and by many others, such as that at Mässing, Bavaria, December 13, 1803, at Weston, Connecticut, U.S.A., December 14, 1807; at Wiborg, Finland, December 13, 1813; at Ausson, France, December 9, 1858; at Baudong, Java, December 10, 1871, &c.

Bristol, January 1. W. F. DENNING.

The Earth's Age.

As Dr. Wallace (NATURE, p. 175) trusts "that on further consideration" I shall "admit that" my "objection is invalid," it is evident that I have failed to make clear to him my argument showing that his data do not warrant his conclusion.

He overlooks the fact that a thickness of 177,200 feet of sedimentary rocks is, standing alone, a perfectly indefinite quantity; to make it definite it must have a definite area.

As he mentions no area for it we are justified in assuming that he means the land area of the globe, whereas his calculation is made as though area were not of the essence of the problem, in short, as if the formation of a pile of sediment 177,200 feet thick, of no matter what area, were the problem.

In Sir A. Geikie's calculation and all other similar ones with which I am acquainted, the thickness of the sedimentary rocks is tacitly assumed to be their thickness all over the land area of the globe.

Dr. Wallace's calculation leads to the absurd result that continents are growing nineteen times as fast as materials are produced to supply their growth.

Leaving the question of the conclusions to which Dr. Wallace's data logically lead, I may say that I am not responsible, and do not hold him to be responsible, for the absurd theory as to the thickness of sedimentary rocks on which they are based.

In order to arrive at a scientifically accurate result, what we require to know is the present actual thickness in every part of the world, plus all the thickness which has previously existed in, but since been denuded away from, every area. The existing thickness in geologically explored areas can perhaps be ascertained within certain limits of error from geological maps and memoirs. For instance where the surface consists of Torridon Sandstone overlying Archæan gneiss of igneous origin, the thickness of sedimentary rock is that of the Torridon Sandstone only, if we assume that the gneiss there is part of the metamorphosed original crust of the earth, for the existence of which Rosenbusch has recently argued.

It is easily demonstrable, first, that in many places the existing thickness of each formation, where undenuded, is far from being the maximum thickness, and, secondly, from the thinning out in some directions, or merging, near the old shoreline, into conglomerates, that some formations were never deposited over certain areas; indeed, the very existence of a sedimentary deposit necessarily implies that of land undergoing denudation and not receiving deposit, although it may well be doubted whether the land area was always nineteen times the area receiving deposit.

Reasoning from the deposits preserved as to those removed by denudation, it is highly improbable that any considerable area ever received either the complete series of deposits, or on the average anything like the maximum thickness of the deposits it actually received. In addition to this, some formations usually considered to be successive may be really contemporaneous, so that the figures representing maximum thicknesses usually taken in calculating the earth's age are probably far above the truth for the purpose in question.

The immense labour involved in calculating the existing thickness of sedimentary rocks in each area, and the thickness which there is any reasonable ground for supposing to have been at any time denuded from that area, as well as the uncertainty of the results, has probably deterred geologists from attempting the task, especially as large areas are very imperfectly known.

BERNARD HOBSON.

Tapton Elms, Sheffield, December 24.

THE first part of Mr. Hobson's letter alone requires notice from me, as the latter part characterizes as absurd the views of those eminent geologists who have estimated the total thickness of the sedimentary rocks, and seems to assume that such writers as the late Dr. Croll and Sir Andrew Ramsay overlooked the very obvious considerations he sets forth.

As regards myself, he reiterates the statement that when geologists have estimated the total thickness of the sedimentary rocks at 177,200 feet, they mean that this amount of sediment has covered the whole land surface of the globe; that, for example, the coal measures, the lias, the chalk, the greensand, the London clay, &c., &c., were each deposited over the whole of the continents, since it is by adding together the thicknesses of these and all other strata that the figure 177,200 feet (equal to 33 miles) has been obtained.

Mr. Hobson concludes with what he seems to think is a *reductio ad absurdum*:—"Dr. Wallace's calculation leads to the absurd result that continents are growing nineteen times as fast as materials are produced to supply their growth."

But the apparent absurdity arises from the absence of any definition of the "growth of continents," and also from supposing that the growth of continents is the problem under discussion. The question is, as to the growth in thickness, of sedimentary deposits such as those which form the geological series. These deposits are each laid down on an area very much smaller than the whole surface of the continent from the denudation of which they are formed. They are therefore necessarily very much thicker than the average thickness of the denuded layer, and the ratio of the area of denudation to the area of deposition, which I have estimated at 19 to 1, gives their proportionate thickness. If Mr. Hobson still maintains that he is right, he can only prove it by adducing *evidence* that every component of the series of sedimentary rocks has once covered the whole land-surface of the globe; not by assuming that it has done so, and characterizing the teaching of all geologists to the contrary as absurd.

ALFRED R. WALLACE.

Ancient Ice Ages.

MR. READE in his letter (NATURE, p. 174) refers to the striations on the pebbles forming the conglomerates at Abberley and the Clent Hills.

Following the late Sir Andrew Ramsay, he considers the deposits to be of glacial origin, but goes further than that distinguished geologist in citing them as proof of a former ice age.

It is but reasonable to suppose that *glaciers* existed in past ages in places where the conditions—such as high altitude and abundant precipitation—were favourable.

Before, however, the existence of a former *glacial period* can be established, we must have evidence of contemporaneous deposits of undoubtedly glacial origin, and extending over wide-spread areas—say half a hemisphere.

J. LOMAS.

University College, Liverpool, December 31.

Printing Mathematics.

THE use of the solidus in printing fractions has been advocated by authorities of such weight that it seems almost a heresy to call it into question. Yet I venture to think that there is a good deal to be said against it. In such matters the course preferred by mathematical writers and their printers is apt to take precedence over that which is most convenient for the great body of those who will read their work. It is tacitly assumed by those who prefer this notation that the getting of mathematical formulæ into line with ordinary printing is an unmixed advantage. No doubt it is easier to set up the work in type thus, but with the consequent rapidity and cheapness of printing the advantage ends. Most people will agree that it is much pleasanter to read a mathematical book in which the letterpress is well spaced, so that the formulæ stand out clearly from the explanatory language, than one in which the two run together in an unbroken stream: just as a book divided into paragraphs is more readable than one which is not. The old style is more restful to the mind and eye, and one can more readily pick out the salient features of the demonstration.

Another aspect of the question seems to me more important. In making any calculation mentally it is much easier to visualize fractions, more especially if complicated, as written in the ordinary way than as written with the new-fashioned notation. The component parts of the mental picture are imagined as spread over a plane instead of being arranged along a line, and can be thought of separately with less confusion. From a similar point of view it will be admitted that it is inconvenient to write mathematical expressions in one form and to print them in another.

Then, again, I doubt whether the assumption that the solidus notation conduces to accuracy is justified. No doubt the printer makes fewer original errors; but whereas with the old notation his frequent glaring errors are more readily detected by the proof-reader (or, if missed by him, by the ordinary reader), with the new notation the misplacement or omission of a solidus is, from the simplicity of the error, likely to be overlooked. In general, no one will be the poorer if a little more trouble is taken with the printing, and a little more paper is used for the book.

The symbol $/$ has advantages over its equivalent $\div$, and to its restricted use, such as is made by Sir G. Stokes, one can hardly object; it matters little how such expressions as a/b or dy/dx are printed. But it is the thin end of the wedge; and one is under a debt of gratitude to Mr. Cassie for showing, in your issue of November 3, to what it may lead. May it be a long time before we have to learn to substitute for the harmless expression, $\dfrac{b^{\frac{1}{2}}}{c(d+e)^3}$ its newest equivalent, $| b \diagdown 1/2 | . / c | d + e \diagdown 3 | !$

I trust that no one will interpret the final note of exclamation as a factorial symbol.

M. J. JACKSON.

D. I. Sind College, Karachi, November 23.

The Teaching of Botany.

I do not think there is at present any book in English giving practical instructions for experiments in Physiological Botany. There is, however, an excellent book of this kind in German, Dr. W. Detmer's "Das pflanzen-physiologische Praktikum," published by Gustav Fischer, Jena, 1888. This, no doubt, contains all that your correspondent "A. H." (NATURE, *ante*, p. 151) requires, though it is perhaps somewhat more advanced than is necessary for school teaching. D. H. SCOTT.

Old Palace, Richmond, Surrey.

THE ORIGIN OF THE YEAR.[1]

IV.

THE reformation of the Egyptian calendar, to be gathered, as I suggested in my last article, from the decree of Tanis, is not, however, the point to which reference is generally made in connection with the decree. The attempt recorded by it to get rid of the vague year is generally dwelt on.

Although the system of reckoning which was based on the vague year had advantages with which it has not been sufficiently credited, undoubtedly it had its drawbacks.

The tetramenes, with their special symbolism of flood, seed, and harvest time, had apparently all meant each in turn; however, the meanings of the signs were changed, the "winter season" occurred in this way in the height of summer, the "sowing time" when the whole land was inundated, and there was no land to plant, and so on. Each festival, too, swept through the year. Still, it is quite certain that information was given by the priests each year in advance, so that agriculture did not suffer; for if this had not been done, the system, instead of dying hard, as it did, would have been abolished thousands of years before.

Before I proceed to state shortly what happened with regard to the fixing of the year, it will be convenient here to state a suggestion that has occurred to me, on astronomical grounds, with regard to the initial change of gn.

It is to be noted that in the old tables of the months, instead of Sirius leading the year, we have Teχi with the two eathers of Amen. In later times this is changed to Sirius.

I believe it is generally acknowledged that the month tables at the Ramesseum is the oldest one we have; there is a variant at Edfu. They both run as follows, and no doubt they had their origin when a 1st Thoth coincided with an heliacal rising and Nile flood.

Egyptian month.	Tropical month.	Ramesseum.	Edfu.
Thoth	June–July	Teχi	Teχ
Phaophi	July–Aug.	Ptah (Ptah-res-aneb-f)	Ptah (Menχ)
Athyr	Aug.–Sep.	Hathor	?
Choiak	Sep.–Oct.	Paχt	Kehek
Tybi	Oct.–Nov.	Min	Set-but
Mechir	Nov.–Dec.	Jackal (reḳḥ-ur)	Hippopotamus (reḳḥur)
Phamenoth	Dec.–Jan.	,, (reḳḥ-netches)	Hippopotamus (reḳḥ-netches)
Pharmuthi	Jan.-Feb.	Rennuti	Renen
Pachon	Feb.–Mar.	χensu	χensu
Payni	Mar.–Ap.	Horus (χonti)	Horus (Hor-χent-χati)
Epiphi	Ap.–May	Åpet	Åpet
Mesori	May–June	Horus (Hor-m-χut)	Horus (Hor-ra-m-χut)

I am informed that Teχi, in the above month-list, has some relation to Thoth. In the early month-list the goddess is represented with the two feathers of Amen, and in this early stage I fancy we can recognize her as Amen-t; but in later copies of the table the symbol is changed to that of *Sirius*. This, then, looks like a change of cult depending upon the introduction of a new star—that is, a star indicating by its heliacal rising the Nile rise after the one first used had become useless for such a purpose.

I have said that the Ramesseum month list is probably the oldest one we have. It is considered by some to date only from Ramses II., and to indicate a fixed year; such, however, is not Krall's opinion.[1] He writes:—

"The latest investigations of Dümichen show that the calendar of Medinet-Abu is only a copy of the original composed under Ramses II. about 120 years before. . . .

"But the true original of the calendar of Medinet-Abu does not even date from the time of Ramses II. It is known to every Egyptologist how little the time of the Ramessids produced what was truly original, how much just this time restricted itself to a reproduction of the traditions of previous generations. In the calendar of Medinet-Abu we have (p. 48) not a fixed year instituted under Ramses II., but the normal year of the old time, the vague year, as it was, to use Dschewhari's words quoted above (p. 852), in the first year of its institution, the year as it was before the Egyptians had made two unwelcome observations: First, that the year of 365 days did not correspond to the reality, but shifted by one day in four years with regard to the seasons; secondly—which of course took a much longer time—that the rising of Sirius ceased to coincide with the beginning of the Nile flood.

"We are led to the same conclusion by a consideration of the festivals given in the calendar of Medinet-Abu. They are almost without exception the festivals which we have found in our previous investigation of the calendars of Esne and Edfu to be attached to the same days. We know already the Uaya festival of the 17th and 18th Thoth, the festival of Hermes of the 19th Thoth, the great feast of Amen beginning on the 19th Paophi, the Osiris festivals of the last decade of Choiak, and that of the coronation of Horus on the 1st Tybi.

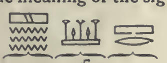
"Festivals somehow differing from the ancient traditions, and general usage are unknown in the calendar of Medinet-Abu, and it is just such festivals which have enabled us to trace fixed years in the calendars of Edfu and Esne.

"We are as little justified in considering the mythologico-astronomical representations and inscriptions on the graves of the time of the Ramessids as founded on a fixed year, as we can do this in the case of the Medinet-Abu calendar. In this the astronomical element of the calendar is quite overgrown by the mythological. Not only was the daily and yearly course of the sun a most important event for the Egyptian astronomer, but the priest also had in his sacred books many mythological records concerning the god Rā, which had to be taken into account in these representations. The mythological ideas dated from the oldest periods of Egyptian history; we shall, therefore, be obliged for their explanation not to remain in the 13th or 14th century before Christ, but to ascend into previous centuries; *I should think about the middle of the fourth millennium before Christ, that is the time at which the true original of the Medinet-Abu calendar was framed.* Further we must in these mythological and astronomical representations not overlook the fact that we cannot expect them to show mathematical accuracy—that, on the contrary, if that is a consideration, we must proceed with the greatest caution. We know now how inexact were the representations and texts of tombs, especially where the Egyptian artist could suppose that no human eye would inspect his work; we also know how often representations stop short for want of room, and how much the contents were mutilated for the sake of symmetry."

[1] Continued from p. 35.

[1] *Op. cit.* p. 48.

There is also, as I have indicated, temple evidence that Sirius was not the first star utilized as a herald of sunrise. We have then this possibility to explain the variation from the true meaning of the signs in Ramessid times.



Pre-Sirian. Texi	Thoth, Phaophi, Athyr, Choiak, Tybi, Mechir, Phamenoth, Pharmuthi, Pachons, Payni, Epiphi, Mesori
Sirian, 3192 B.C.	Thoth, Phaophi, Athyr, Choiak, Tybi, Mechir, Phamenoth, Pharmuthi, Pachons, Payni, Epiphi, Mesori

And it may be gathered from this that the Calendar was reorganized[1] when the Sirius worship came in and that the change effected in 619 B.C. brought the hieroglyphic signs back to their natural meaning and first use.

Before I pass on it may be convenient in connection with the above month-tables to refer in the briefest way to the mythology relating to the yearly movement of the sun, in order to show that when this question is considered at all, if it helps us with regard to the mythology connected with the rising and setting of stars, it will as assuredly help us with regard to the mythology of the various changes which occur throughout the year.

We have, as we have seen, in the Egyptian year really the prototype of our own. The Egyptians, thousands of years ago, had an almost perfect year containing twelve months, but instead of four seasons they had three, the time of the sowing, the time of the harvest, and the time of the inundation. Unfortunately, at various times in Egyptian history, the symbols for the tetramenes seem to have got changed.

The above-given inscriptions show that they had a distinct symbolism for each of the months. Gods or goddesses are given for ten months out of the twelve, and where we have not these, we have the hippopotamus (or the pig) and the jackal, two circumpolar constellations. I think there is no question that we are dealing here with these constellations, though the figures have been supposed to represent something quite different.

There are also myths and symbols of the twelve changes during the twelve hours of the day; the sun being figured as a child at rising, as an old man when setting in the evening. These ideas were also transferred to the annual motion of the sun. In Macrobius, as quoted by Krall, we find the statement that the Egyptians compared the yearly course of the sun also with the phases of human life.

Little child	=	Winter solstice.
Young man	=	Spring equinox.
Bearded man	=	Summer solstice.
Old man	=	Autumnal equinox.

With the day of the summer solstice the sun reaches the greatest northern rising amplitude, and at the winter solstice its greatest southern amplitude. By the solstices the year is divided into two approximately equal parts; during the one the points of rising move southwards, during the other northwards.

This phenomenon, it is stated, was symbolized by the two eyes of Rā, the so-called Utchats, which look in different directions. They appear as representing the sun in the two halves of the year.

We have next to discuss the fixed year, to which the Egyptian chronologists were finally driven in later Egyptian times.

The decree of Tanis was the true precursor of the Julian correction of the calendar. In consequence of this correction *we* now add a day every four years to the end of February. The decree regulated the addition, by the Egyptians, of a day every four years by adding a day to the epacts, which were thus 6 every four years instead of being always 5 as they had been before.

In fact it replaced the vague year by the sacred year long known to the priests.

But if everything had gone on then as the priests of Tanis imagined, the Egyptian new year's day, *if* determined by the heliacal rising of Sirius, would not always afterwards have been the 1st of Payni, although the solstice and Nile flood would have been due at Memphis about the 1st of Pachons; and this is, perhaps, one among the reasons why the decree was to a large extent ignored.

Hence, for some years after the date of the decree of Tanis there were at least three years in force: the new fixed year, the new vague year, reckoning from Pachons, and the old vague year, reckoning from Thoth.

But after some years another attempt was made to get rid of all this confusion. The time was 23 B.C., 216 years after the decree of Tanis, and the place was Alexandria. Hence the new fixed year introduced is termed the Alexandrine year.

This new attempt obviously implied that the first one had failed; and the fact that the vague year was continued in the interval is sufficiently demonstrated by the fact that the new year was $\frac{216}{4}=54$ days *en retard*. In the year of Tanis it is stated that the 1st Pachons, the new New Year's Day, the real beginning of the flood, fell on the 19th of June (Gregorian), the summer solstice, and hence the 1st of Thoth fell on the 22nd of October (Gregorian). In the Alexandrine year the 22nd of October is represented by the 29th of August, and the 19th of June by the 20th of April.

It is noteworthy that in the Alexandrine year the heliacal rising of Sirius on the 23rd of July (Julian) falls on the 29th of Epiphi, nearly the same date as that to which I first drew attention in the inscriptions of the date of Thotmes and Pepi. This, however, it is now clearly seen, is a pure accident, due to the break of continuity before the Tanis year, and the *slip* between that and the Alexandrine one. It is important to mention this, because it has been thought that somehow the "Alexandrine year" was in use in Pepi's time!

It would seem that the Alexandrine revision was final, and that the year was truly fixed, and from that time to this it has remained so, and must in the future for ever remain so. It must never be forgotten that we owe this perfection to the Egyptians.

One of the chief uses of the Egyptian calendar that has come down to us was the arrangement and dating of the chief feasts throughout the year in the different temples.

The fact that the two great complete feast calendars of Edfu and Esne refer to the only fixed years evidenced by records, those of Tanis and Alexandria, one of which was established over 200 years after the other, is of inestimable value for the investigation of the calendar and chronology of ancient Egypt.

In an excellent work of Brugsch, "Three Festival Calendars from the Temple of Apollinopolis Magna (Edfu) in Upper Egypt," we have two calendars which we can refer to fixed years, and can date with the greatest accuracy. In the case of one of these, that of Esne, this is universally recognized; as to the other, that of Apollinopolis Magna, we are indebted to the researches of Krall, who points out, however, that "it is only when the province of Egyptian mythology has been dealt with in all directions, that we can undertake a successful explanation of the festival catalogues. Even externally they show the greatest eccentricities, which are not diminished but increased on a closer investigation."

[1] Goodwin has already asked, "Does the Smith Papyrus refer to some rectification of the Calendar made in the 4th Dynasty, similar to that made in Europe from the old to the new style," quoted by Riel, "Sonnen- und Sirius-Jahr," p. 361.

About some points, however, there is no question. The summer solstice is attached in the Edfu calendar to the 6th Pachons, according to Krall, while the beginning of the flood is noted on the 1st of that month. In the Esne calendar, the 26th Payni is New Year's Day. We read:—"26th Payni, New Year's Day, Feast of the Revelation of Kahi in the Temple. To dress the crocodiles, as in the month of Mechir, day 8."

Peculiar to the Esne calendar, according to Krall, is the mentioning of the "New Year's Festival of the Ancestors" on the 9th of Thoth; to the Edfu calendar, publication No. 1 of Brugsch, the festival "of the offering of the first of the harvested fruits, after the precept of King Amenemhā I.," on the 1st Epiphi, and "the celebration of the feast of the great conflagration" on the 9th of Mechir. In feast calendar No. 1, the reference to the peculiar Feast of Set, is also remarkable, this was celebrated twice, first in the first days of Thoth (? 9th ?), then, as it appears, in Pachons (10th). This feast is well known to have been first mentioned under the old Pharaoh Pepi Merinrā.

It is a question whether in the new year of the ancestors and the feasts of Set, all occurring about the 9th Thoth and Pachons, we have not Memphis Festivals which gave way to Theban ones, for so far as I can make out the flood takes about nine days to pass from Thebes to Memphis, so that in Theban time the arrival of the flood at Memphis would occur on 9th or 10th Thoth. There is no difficulty about the second dating in Pachons, for as we have seen this followed on the reconstruction of the calendar.

It is also worthy of note that the feast of the "Great Conflagration" took place very near the Spring Equinox.

It is well to dwell for a moment on the Edfu inscriptions to see if we can learn from them whether they bear out or not the views brought forward with regard to this reconstruction.

As we have seen it is now acknowledged that the temple inscriptions at Edfu (which are stated to have been cut between 117 and 81 B.C.) are based upon the fixed year of Tanis; hence we should expect that the rising of Sirius would be referred to on 1 Payni, and this is so. But here, as in the other temples, we get double dates referring to the old calendars, and we find the "wounding of Set" referred to on the 1st Epiphi and the rising of Sirius referred to under 1 Mesori. Now this means, if the old vague year is referred to, as it most probably is, that

5 Epacts
30 Mesori
—
$35 \times 4 = 140$ years

had elapsed since the beginning of a Sothic cycle, when the calendar coincidences were determined, which were afterwards inscribed on the temple walls. We have, then, 140 years to subtract from the beginning of the cycle in 270 B.C. This gives us 130 B.C., and it will be seen that this agrees as closely as can be expected with my view, whereas the inscription has no meaning at all if we take the date given by Censorinus.

I quote from Krall[2] another inscription common to Edfu and Esne, which seems to have astronomical significance.

"1. Phamenot. Festival of the suspension of the sky by Ptah, by the side of the god Harschaf, the master of Heracleopolis Magna (A1). Festival of Ptah. Feast of the suspension of the sky (Es).

"Under the 1st Phamenot, Plutarch, de Iside ac Osiride c. 43, b, notices the *ἔμβασις Ὀσίριδος εἰς τὴν σελήνην*. These are festivals connected with the celebration of the winter solstice, and the filling of the Uza-eye on the 30th Mechir. Perhaps the old year, which the Egyptians introduced into the Nile valley at the time of their immigration, and which had only 360 days, commenced with the winter solstice. Thus we should have in the 'festival of the suspension of the sky,' by the ancient god Ptah—venerated as creator of the world—a remnant of the time when the winter solstice . . . . marked the beginning of the year, and also the creation."

The reconstruction of the calendar naturally enhanced the importance of the month Pachons; this comes out very clearly from the inscriptions translated by Brugsch. On this point Krall remarks:—

"It is therefore quite right that the month Pachons, *which took the place of the old Thoth by the decree of Tanis*, should play a prominent part in the feast calendars of the days of the Ptolemies, and the first period of the Empire in general, but especially in the *Edfu* calendar, which refers to the *Tanitic* year. The first five days of Pachons are dedicated in our calendar to the celebration of the subjection of the enemies by Horus; we at once remember the above mentioned (p. 7) record of Edfu of the nature of a mythological calendar, describing the advent of the Nile flood. On the 6th of Pachons—remember the great importance of the sixes in the Ptolemæan records—the solstice is then celebrated. The Uza-eye is then filled, a mythical act which we have in another place referred to the celebration of the solstice, and "everything is performed which is ordained" in the book "on the Divine Birth."

Next let us turn to Esne. The inscriptions here are stated to be based on the Alexandrian year, but we not only find 1st Thoth given as New Year's Day, but 26 Payni given as the beginning of the Nile flood.

Now I have already stated that the Alexandrine year was practically a fixing of the vague Tanis year; that is, a year beginning on 1st Pachons in 239 B.C.

If we assume the date of the calendar coincidences recorded at Esne to have been 15 B.C. (we know it was after 23 B.C. and at the end of the Roman dominion), we have as before, seeing that, if the vague Tanis year had really continued, it would have swept forward with regard to the Nile flood,

Pachons 30
Payni 26
—
$56 \times 4 = 224$ years after 239 B.C.

This double dating, then, proves the continuation of the vague year of Tanis if the date 15 B.C. of the inscription is about right.

Can we go further and find a trace of the old cycle beginning 270 B.C.? In this case we should have the rising of Sirius

$$\begin{array}{r} 270 \\ -\ 15 \\ \hline 4)255 \text{ years} \\ \hline 64 = \text{say 5 Epacts and 2 months.} \end{array}$$

This would give us 1 Epiphi. Is this mentioned in the Esne calendar? Yes, it is, "1 Epiphi. To perform the precepts of the book on the second divine birth of the child Kahi."

Now the 26th Payni, the new New's Year Day, is associated with the "revelation of Kahi," so it is not impossible that "the second divine birth" may have some dim reference to the feast.

It is not necessary to pursue this intricate subject further in this place; so intricate is it that, although the suggestions I have ventured to make on astronomical grounds seem consistent with the available facts, they are suggestions only, and a long labour on the part of Egyptologists will be needed before we can be said to be on firm ground.

J. NORMAN LOCKYER.

[1] On the 7th Epiphi of the 10th year of Ptolemy III. the ceremony of the stretching of the cord took place, Dümicher., Aëg. Z. 2, 1872, p. 41.
[2] *Op. cit.*, p. 37.

PROPOSED HANDBOOK TO THE BRITISH MARINE FAUNA.

THE admirable monographs issued under the auspices of the Ray Society, and in Van Voorst's series, by such well-known authorities as Forbes and Hanley, Alder and Hancock, M'Intosh, Allman, Hincks, Brady, Norman, and others, are amongst the most creditable and useful productions of British Zoology, and all naturalists must devoutly trust that there are still others of a like classical nature to follow, and that, for example, Prof. M'Intosh will soon be able to complete his long-expected work on the British Polychæta.

But many Marine zoologists feel that, quite apart from such exhaustive and expensive monographs, and only aspiring to occupy a very much humbler position, there is pressing need of a "pocket" or seaside "Invertebrate Fauna," which could be used in much the same way as the botanists' "Field Flora." It has been suggested to me more than once during the last few years that I would be doing useful work in compiling such a book; and as no one else seems ready or willing to do so, I feel inclined to make the attempt. Some material has already been accumulated for the purpose, but before going further I wish to lay my views before my fellow zoologists, in the hope that they will be kind enough to criticize the scheme and give me the benefit of their advice.

The only existing work of the kind is Gosse's well-known, and, so far as it goes, very excellent little "Manual of Marine Zoology," but that book does not really meet the present want, as not only is the date of publication 1855-6, since when the number of genera and species has probably been something like doubled, but also Gosse merely gives the names of the species, while the book I think of would, in order to be of any real use, require to aim at giving a brief but sufficient diagnosis and figure of every British species. I would adopt as "British" the area defined by Canon Norman's British Association Committee in 1887.

Probably the most convenient form of publication would be some four to six small volumes, each dealing with one or two of the large groups. This would allow of the groups being published as they were ready, not necessarily in zoological order, and would also be convenient for the use of those interested in one set of animals.

There would be definitions—perhaps with occasional analytical tables or keys—of orders, families, &c., down to and including genera. Under each genus would be given all sufficiently defined species with a brief description of each either in tabular form or in series, as seems most suitable in each case, and with an indication of size, range, and habitat. Many species might be described very briefly in terms of preceding species, the differences merely being pointed out. By simplicity of language, avoidance of unnecessary repetition, and use of contractions it might be hoped that each species could be confined on an average to a couple of lines.

Illustrations would be either in the form of numerous small outline figures on thin paper plates inserted as near as possible to the pages where the descriptions occur, or as small groups of cuts (as in "Gosse") in the text. There would be a figure of the whole animal in each important genus, or small family, and the figures of the species would represent the diagnostic points only, *e.g.* in the zoophytes there would be a figure in the genus *Plumularia* of an entire colony, or shoot, while the species *pinnata*, *setacea*, *catharina*, &c., would be represented each by a small figure showing the pinnæ, calycles, or nematophores as the case required.

I shall now give a few examples, taken from different groups, of the method in which the genera and species might be treated, in order that specialists may have the opportunity of judging and criticizing.

I. From Cœlenterata :—Genus ANTENNULARIA.

Stems simple or branched; pinnæ verticillate; nematophores along the stems; gonothecæ axillary, unilateral.

A. antennina, L., stems clustered, usually simple; hydrothecæ separated by 2 joints. 6 to 9 in. high. Gen. distr. deep w.

A. ramosa, Lamk., stems single, usually branched; hydrothecæ separated by 1 joint only. 6 to 9 in. high. Gen. distr. deep w.

II. From Crustacea :—Family MAIIDÆ.

HYAS. Carapace tuberculous, no spines; branches of rostrum not divaricated; second joint of antenna dilated; no teeth beneath last joint of walking legs.

H. araneus, L., carapace not contracted behind post-orbital process. 3 in. Common, shallow.

H. coarctatus, Leach, carapace contracted behind post-orbital process. 1 in. Gen. distr. shallow.

PISA. Carapace may be tuberculous, with strong postero-lateral spine; branches of rostrum divaricated at extremity; second joint of antenna slender; terminal joint of walking legs toothed beneath.

P. tetraodon, Leach, carapace with small tubercles; antero-lateral margin with 4 spines. 2 in. Rare, S. coast.

P. gibbsii, Leach, carapace with large rounded elevations, but no tubercles, no spines on antero-lateral margin. Rare, deep w., S. coast.

MAIA. Carapace covered with numerous sharp spines; branches of rostrum strongly divaricated; no teeth beneath terminal joint of walking legs.

M. squinado, Latr. 10 in. long. S. and W. coasts o England.

III. From Tunicata :—Family MOLGULIDÆ.

EUGYRA. Branchial sac with no folds.

E. glutinans. Möll., circular area on side free from sand. ½ in. Shallow w., gen. distr.

E. globosa, Hanc., entirely covered with sand. ½ in.

PERA. Bran. s. with 5 folds each side.

P. hancocki, Hrdn., matted fibres at poster. end. ½ in. Irish Sea, 20 fms.

MOLGULA. Bran. s. with 6 or 7 folds each side.

M. inconspicua, A. & H., 6 folds, sandy, dors. lam. entire, no pap. on stigmata. ¼ in.

M. impura, Hel., 6 folds, sandy, small papillæ on edges of stigmata. 1 in. W. of Ireland, shallow.

M. simplex, A. & H., few hairs, little or no sand, 6 folds, anus fringed, dors. tub. horse-shoe, aperture to left. ½–¾ in.

M. tubifera, Örst., 6 folds, anus fringed, dors. tub. horse-shoe, dors. lam. toothed, sandy. 1 in. E. coast.

M. ampulloides, v. Ben., 6 folds, anus fringed, dors. tub. horse-shoe, 3 bars on fold, dors. lam. entire. 1 in. E. coast, shallow.

M. socialis, Ald., 6 folds, anus fringed, dors. tub. horse-shoe, 4 bars on fold, dors. lam. entire, sandy, gregarious. ½ in. shallow w. S. coast.

M. holtiana, Hrdn., 6 folds, dors. tub. serpentif., hairs but little sand on test. ¾ in. W. of Ireland, 10 fms.

M. occulta, Kupf., 7 folds, dors. tub. horse-shoe, dors. lam. toothed, whole body sandy. 1 in. Shallow w. S. and W. coasts.

M. oculata, Forb., 7 folds, siphonal region alone free from sand, and retractile between folds of test. 1 in. Gen. distr. Shallow w.

M. cæpiformis, Hrdn., 7 folds, globular, not attached, no sand. ¾ in. S. coast, shallow w.

M. citrina, A. & H., 7 folds, attached by left side, no sand. ¼–½ in. under st., litt. E. and W. coasts.

CTENICELLA, as MOLGULA, but branchial and atrial lobes laciniated.

C. complanata, A. & H., 6 folds on left, 7 on right, depressed, attached, sandy, ¼ in.

In conclusion, I need scarcely say that I shall be very grateful for suggestions, and, if the work is carried on, for any information from specialists about less known species, and the discrimination of allied forms, and for specimens, and also for references to any descriptions which might be likely to escape my notice.

W. A. HERDMAN.

NOTES.

IN consequence of the unavoidable absence abroad of the new President of the Institution of Electrical Engineers, Mr. W. H. Preece, F.R.S., on the 12th inst., he will deliver his inaugural address on the 26th inst.

A PUBLIC meeting, arranged by the Technical Instruction Committee of the Essex County Council, will be held in the Shire Hall, Chelmsford, on Friday afternoon, January 13, at 4.30 p.m., Lord Rayleigh in the chair. An address will be given by Sir Henry E. Roscoe on technical instruction in agricultural counties, with especial reference to science teaching. Afterwards a discussion will take place.

DR. PERCY RENDALL, F.Z.S., has accepted an appointment as Resident Medical Officer to the Sheba Gold-mining Company in the Barberton District of the Transvaal. He will reside at Eureka City, at an elevation of 5000 feet above the sea-level. Dr. Rendall made a good collection of birds during his recent residence at Bathurst on the Gambia, of which he has given an account in the *Ibis* for last year (*Ibis*, 1892, p. 215). He has also made many valuable donations to the Zoological Society's Menagerie, amongst which is the unique example of the Nagor Antelope (*Cervicapra redunca*), presented by him in June, 1890. Of this scarce animal there is, we believe, no example in the British Museum. Dr. Rendall's new appointment will give him many opportunities of extending our zoological knowledge of a little known district.

LORD WALSINGHAM, who has devoted much of his attention to the micro-lepidoptera, has filled the vacancy on the staff of the *Entomologists' Monthly Magazine* occasioned by the death of Mr. Stainton.

LAST week a preliminary meeting was held at the house of Sir James Paget to consider what steps should be taken with regard to a memorial of Sir Richard Owen. It was decided that a committee should be formed to make the necessary preparations. The following, among others, have consented to serve as members:—The Presidents of the Royal Colleges of Physicians and Surgeons and of most of the scientific societies, the Duke of Teck, Lord Playfair, Prof. Huxley, Sir Joseph Hooker, Sir Henry Acland, Sir John Evans, Dr. Michael Foster, Mr. Sclater, Sir W. Savory, Mr. Hulke, Sir Joseph Fayrer, Sir Edward Fry, Dr. Günther, Mr. Carruthers and Dr. H. Woodward. Sir William Flower will act as treasurer, and a general meeting will shortly be called. It has been suggested that the memorial should be a marble statue, to be placed in the hall of the Natural History Museum.

PROF. WESTWOOD, who died on Monday at the age of eighty-seven, will be greatly missed at Oxford. To most people he is known chiefly as a writer on the archæology and palæography of art, but he was equally eminent as an entomologist. He was one of the founders of the Entomological Society, and received one of the Royal Society's gold medals for his entomological researches.

WE regret to record the death of General Axel Wilhelmovitch Gadolin, an old member of the Russian Academy of Sciences. He was born of Finnish parents on July 10, 1828, received his education in the Finnish Corps of Cadets, and till his death remained in the Russian Artillery, devoting his leisure time to mineralogical, and especially to mathematical, researches into the molecular forces which act in the formation of crystals. One of his earlier works, published in the *Verhandlungen der Mineralogischen Gesellschaft zu St. Petersburg*, was on some minerals from Pitkäranta. His chief work, published in 1867, was his "Deduction of all the Systems of Crystals and their Derivates from a Unique Principle." A deep impression was produced upon the members of the Russian Mineralogical Society by Gadolin's first communication upon this subject. The lucidity with which he deduced all systems of crystallization from fundamental principles of equilibrium of molecular forces, and the simplicity of the exposition of his researches, entirely based upon high mathematical analysis, reminded his hearers of some of the best pages of Laplace's writings. The work soon became widely known in a German translation. A paper on the resistance of the walls of a gun to the pressure of gunpowder gases also deserves mention, as, in addition to the formerly known formulæ of highest resistance of cylinders, he gave a new formula of minimal resistance. Later on his method was used with great success by Klebsch, in his well-known "Theorie der Elasticität fester Körper," for deducing some general equations of equilibrium of solid bodies.

THE last issue of the *Izvestia* of the East Siberian Geographical Society (vol. xxiii. 3) contains an obituary notice by V. Obrutcheff, of I. D. Chersky, who died in the far north-east of Siberia, during his expedition to the Kolyma river, after having given many years of his life to the active geological exploration of Siberia. He began his work in 1872 at Omsk, where he made most valuable discoveries of post-tertiary mammals. During the next two years he explored the Tunka and Kitoi Alps, but his rich materials were lost during the great conflagration at Irkutsk in 1879. In 1875 and 1876 he explored the Nijneudinsk caves, making again remarkable finds of quaternary mammals; and then he gave fully five years to the study of the stores of Lake Baikal, embodying the results of his extensive researches in a map (6·7 miles to the inch), and in vol. xii. of the *Memoirs* of the East Siberian Society, and vol. xv. of the *Memoirs* of the Russian Geographical Society. In 1882 and 1883 he explored the Lower Tunguska, and again made rich finds of fossil mammals. The next five years he spent at the Academy of St. Petersburg, preparing the part of Ritter's "Asia" which is devoted to Lake Baikal, and working out the rich materials collected by another lamented Polish explorer of East Siberia, Czekanowski. He also worked out the collections brought in from the New Siberia Islands by MM. Bunge and Toll, and came to such interesting and new conclusions as to the recent geological history of Arctic Siberia, that the Academy of Sciences sent him out in 1891, at the head of a new expedition to the Kolyma region. There he died, in the midst of his promising work.

THE twentieth annual dinner of the old students of the Royal School of Mines will be held at the Holborn Restaurant, on Tuesday, January 10, at 7 o'clock. The chair will be taken by Mr. W. Gowland, late of the Imperial Mint, Osaka, Japan.

MR. G. T. ATKINSON has been appointed Professor of Cryptogamic Botany at Cornell University, Ithaca, State of New York, in the place of Prof. W. R. Dudley, who has gone to the Leland-Stanford University, Paolo Alto, California.

AT the next public meeting of the French Academy, in December 1893, forty-five prizes will be awarded for the best work tending to the advancement of the various branches of science. Of these, the following are, by the terms of the bequests, open to competitors of all nationalities. The Prix Lalande will be awarded for the most intereresting observation, or the memoir or work most useful for the progress of Astronomy. Its value is 540 francs. The Prix Valz, of 460 francs, is offered under the same conditions. Three prizes of 10,000 francs each, bequeathed by M. L. La Caze, will be awarded annually for the best contributions to Physiology, Physics, and Chemistry respectively. The Prix Tchihatchef, of 3000 francs, is offered annually to naturalists who have distinguished themselves most in the exploration of the continent of Asia or the adjacent isles

excluding better known regions such as British India, Siberia proper, Asia Minor, and Syria. The explorations must have some object connected with Natural Science, physical or mathematical, and will not be awarded for archæological or ethnographic work. All these prizes will be awarded in December 1893. Works for competition to be sent in to the *Sécrétariat* before June 1. The Prix Leconte, of 50,000 francs, for the most important scientific discovery, will be awarded in 1895.

THE Royal Academy of Sciences of Turin, in accordance with the will of Dr. Cesare Alessandro Bressa, and in conformity with the programme published December 7, 1876, announces that the term for competition for scientific works and discoveries in the years 1889–92, to which only Italian authors and inventors were entitled, was closed on December 31, 1892. The ninth Bressa prize will be given to the scientific author or inventor, whatever be his nationality, who during the years 1891–94, "according to the judgment of the Royal Academy of Sciences of Turin, shall have made the most important and useful discovery, or published the most valuable work on physical and experimental science, natural history, mathematics, chemistry, physiology and pathology, as well as geology, history, geography and statistics." The term will be closed at the end of December 1894. The sum fixed for the prize, income tax being deducted, is 10,416 francs. Any one who proposes to compete must declare his intention within the time above mentioned, by means of a letter addressed to the President of the Academy, and send the work he wishes to be considered. The work must be printed. Works which do not obtain the prize will be returned to the authors, when asked for within six months from the adjudication of the prize. None of the national members, resident or not resident, of the Turin Academy can obtain the prize. The Academy gives the prize to the scientific man considered most worthy of it, even if he has not competed.

MESSRS. MACMILLAN AND CO. hope to publish early in the spring the second volume of Dr. Arthur Gamgee's Treatise on Physiological Chemistry. This volume, which deals with the Digestive Processes, will be followed at no long interval by an enlarged and revised edition of the first volume, which originally appeared in 1880.

THE United States Government is inviting the various European Governments to send delegates to an International Conference of Meteorologists, to be held at Washington. The following is said to be proposed as a provisional programme of topics to be discussed by the Conference: (*a*) The organization of additional meteorological work for the benefit of agriculture. (*b*) The extension to all ports frequented by commerce of the benefits of systematic storm and weather signals, and the introduction of a uniform system of storm warnings throughout the world. (*c*) The co-operation of all nations in the publication of a daily chart of the weather over all the habited lands and frequented oceans for the study of the atmosphere as a whole, and as preparatory to the eventual possibility of predicting important changes several days in advance. (*d*) The equable apportionment of stations, publications, and expenses among the nations, and the suggestion of practical methods by which to secure observations from those countries that are not represented in this Conference. (*e*) The encouragement by the respective Governments of special scientific investigations looking to the advancement of meteorology. Such other matters as the delegates may think advisable to submit for discussion, or for future report, will also be considered.

DURING the past week the sharp frost has continued almost uninterruptedly over these islands, with the exception of a partial thaw on Friday and Saturday, caused by a disturbance in the west spreading to the eastward. The greatest increase of temperature occurred in the north and west, but in the south-east of England the day readings were only slightly above the freezing-point. There was a complete change in the type of weather at the close of the week; a large anticyclone had formed over Scandinavia, and the air over nearly the whole of Europe was intensely cold, the minimum in the shade at Haparanda on Sunday registering 72° below the freezing-point, and the barometer on subsequent days rose to 31 inches and upwards in these islands. These conditions were accompanied by cold easterly gales in the south-west of England, while a heavy fall of snow was experienced in the south-eastern districts. On the coast of Kent the shade minimum fell to 11° during Monday night. The *Weekly Weather Report* issued on December 31 shows that the temperature of that period was much below the mean, amounting to 9° or 10° over the greater part of England, and to 12° in the Midland counties. Very little rain fell during the week; the deficiency of rainfall in the south-western district of England for the last year amounts to 10·8 inches, or more than 25 per cent. below the average of the 25 years 1866–90. A good deal of fog was experienced at the inland stations during the week.

SOME very interesting entomological notes from the Eastern Archipelago are given by Mr. J. J. Walker in the January number of the *Entomologists' Monthly Magazine*. Incidentally Mr. Walker mentions that Dr. Wallace's residence in these islands, after a lapse of more than thirty years, is not forgotten, and that the Dutch translation of the "Malay Archipelago" is "as highly appreciated in the lands of which he gives so vivid a picture as the original work is at home."

AT the Physikalisch-Technische Reichsanstalt, Berlin, copies of standard mercury resistances are being constructed in which the mercury does not require renewal (*Wiedemann's Annalen*). They consist of U-shaped tubes filled with mercury in a vacuum and then sealed by fusion. Into each of the ends are fused three thin platinum wires connecting with the main current, the secondary circuit, and the galvanometer respectively. Since the connections are rigidly joined to the glass, it is possible to employ platinum wires as thin as 0·3 mm. so that there is no danger of heat being conducted into the mercury from without. The copy, mounted in a perforated brass box with an ebonite lid, is immersed in petroleum contained in another brass box, so that the binding screws are covered. This box is again surrounded during the experiment with a mixture of fine ice and water. The resistance is thus taken at a temperature which can easily be obtained, and which is uniform throughout the containing vessel.

AN apparatus for demonstrating the difference of potential at the poles of a galvanic cell has been constructed by Messrs. Elster and Geitel, of Wolfenbüttel (*Zeitschr. für Phys. und Chem. Unterricht*). It is a modification of Thomson's water-dropping influence machine. Two insulated metallic vessels can be filled with water by pressing a rubber ball communicating with a three-necked jar. The jets enter the vessels through two metal rings. One of these rings is connected with the positive pole of the cell. The jet on passing through becomes negatively charged, and the charge is communicated to the vessel and through a wire to the second ring, which acts by induction on the other jet. A strong positive charge is soon accumulated on the outside of the second vessel, and can be exhibited by a gold leaf or aluminium foil electroscope.

IN 1869 it was decided, in France, to give a medal and pension of 250 francs to every old soldier of the Republic and the Empire who could show two years of service, or two campaigns, or a wound. An interesting statistical record of these "médaillés de Sainte Hélène" as of "a generation which is disappearing," is given by M. Turquan in the *Revue Scientifique*. The first list, in 1870, comprised 43,592 names; and these men

must have almost exclusively served under the Empire. They are now reduced to 27. The oldest, Vivien by name, a Lyons man, is now 106. When 13 he was with Bonaparte in Egypt, fought in 22 campaigns, and was one of the Imperial Guard at Waterloo. The youngest is 92, and served in the navy. The mean age of the 27 survivors is 97 or 98 years. The annual number of deaths in this body of men reached a maximum of 6456 in 1872, since which year it has been gradually diminishing. The proportional mortality rose, in general, till 1889, but in the years since there has been a marked fall, testifying to the exceptional vitality of those late survivors. M. Turquan calculates that this remnant will have wholly disappeared by the end of the century. Going back to 1815, he estimates the generation to which the men belong at about 300,000, with a mean age of 25 years, and that 500,000 births between 1785 and 1795 would concur to its formation. From figures relating to the Napoleonic wars he comes to the grim conclusion that one man in five of those born between the years just named was destined to die in war. It is, he says, to the immense losses of men during the ten years of war of the Empire that the present generations owe their low birth-rate.

MR. J. R. S. CLIFFORD offers some interesting observations in the January number of *Nature Notes*—the Selborne Society's magazine—on the Death's-head moth and bees. Last July a friend of his at Gravesend found one of these huge moths trying to gain access to a hive, having evidently been drawn to the spot by the odour of the honey. This disposes of doubts which have been suggested as to the old statements about this moth's habit of entering hives when it has a chance. The construction of modern hives keeps it out, but "where old-style hives are used, the moth can and does enter, and occasionally one has been found dead within a hive, the bees, being unable to remove so bulky an insect, having taken the precaution to embalm its body with what is called *propolis*." According to Mr. Clifford, some Continental bee-keepers have discovered that "the bees are aware they are liable to the intrusions of this big moth," and when the bees are "located in the old-fashioned hive, the insects erect a kind of fortification at the portal. This is constructed with a narrow passage and a bend, past which the Death's-head could not possibly make its way, and which it has no jaws to bite through."

WE learn from the *Agricultural Journal*, issued by the Department of Agriculture at Cape Colony, that much attention is being given there to questions connected with the fruit export trade. The department is in correspondence with the steamship companies with a view to securing every possible encouragement to the trade, which is expected to be taken up on a considerable scale this year. Replying to inquiries on the subject, the Castle Mail Packets Company announce that they will give every publicity to the rates of freight to be charged and the stowage arrangements, &c. The Company will also concede a somewhat lower rate for the less remunerative fruits carried in the cool chambers, and will reserve a cool and well-ventilated part of the vessel for conveyance of fruit as ordinary cargo. Careful instructions have been issued to captains of the Company's vessels in regard to the stowage and carriage of fruit.

DR. THEODORE MAXWELL has issued a useful catalogue of Russian medical dissertations and other works he has collected and presented to the Royal College of Surgeons of England. In order that the dissertations may be of service to students who do not read Russian, he has indicated the nature of each work in English, and has given references to such abstracts in the *Lancet* or elsewhere as he has himself made or happens to be acquainted with.

AN excellent "Child Life Almanack" for 1893, by A. M. Clive Bayley, has been published by Messrs. G. Philip and Son. It is issued as an extra number of "Child Life," and the object, as the author explains, is to provide teachers with suggestions both for lessons to be prepared and observations to be made. Teachers who may wish to give "seasonable" lessons will find many most useful hints as to what really goes on in nature during the various periods of the year.

MR. JOHN BROWNING, optical and physical instrument maker, has issued an illustrated catalogue of magic, dissolving view, and optical lanterns, lime-light apparatus, and slides.

THE extraordinary diversity in the temperature at which different micro-organisms flourish and multiply, has from time to time been the subject of some interesting investigations by Fischer, Globig, and others. Thus Fischer isolated fourteen different species of bacteria from the sea-water in Kiel harbour, and from soil in the town itself. These he was actually able to cultivate successfully at the freezing temperature (0° C.) as well as at from 15° to 20° C. Globig, on the other hand, studied the behaviour of micro-organisms at high temperatures and separated out no less than thirty varieties from garden soil which would grow at 60° C. Some of these were even able to develop at 70° C., whilst the majority refused to grow at all below 50° C., some still more fastidious individuals objected to any temperature below 60° C., and others again required a temperature of between 54° and 68° C. One bacillus, however, was discovered more catholic in its taste in this respect, for whilst growing at 68° C. it managed to develop also at from 15° to 20° C. Some fresh contributions on the growth of micro-organisms at low temperatures have recently been made by Forster of Amsterdam ("*Ueber die Entwickelung von Bakterien bei niederen Temperaturen*"). As far back as 1887 Forster described a phosphorescent bacillus obtained from sea-water which was found not only capable of growing, but of producing the phenomenon of phosphorescence at 0° C. In further researches made by this investigator in conjunction with Bleekrode, it is stated that, although not many different species were found by them to develop at 0° C., yet immense numbers of individual bacteria belonging to this category were detected in very various media. Thus one cubic centimetre of milk as sent into the market contained 1000 such micro-organisms, whilst in a single gram of garden soil as many as 140,000 were found. Large numbers of such bacteria were also present in sea-water obtained from the North Sea, and they were also found on the surface of fresh water fish as well as in their alimentary tract. It is well known that to successfully preserve meat and other articles of food it is necessary to employ a much lower temperature than 0° C., and experience has further shown that this is best done when the atmosphere is deprived of all moisture, as is accomplished by the compression and subsequent expansion of the air in enclosed spaces. Haddocks imported from Norway and thus artificially frozen were examined by Forster for bacteria. These fish were first killed and then exposed to a temperature of from 20° to 40° below 0° C. until they became perfectly hard and stiffly frozen, when they were removed to a cold chamber in which the temperature varied from 8° to 15° below 0° C. In spite of the extremely low temperature to which these fish had been subjected, on examining them when still hard frozen, a considerable number of bacteria were found in the abdominal cavity which had been opened when the fish was killed. It is obvious that during the interval which elapsed between the killing of the fish and their transference to the freezing chamber, bacteria must have been able to gain access, but had not had time to multiply to any considerable extent before the fish was frozen. Forster points out, what is sufficiently apparent, that the packing of samples of water in ice when sent from a distance

for bacteriological examination to prevent the multiplication of the micro-organisms present, is really of very little if any use at all. Thus it was already shown several years ago by Percy Frankland that the bacteria in filtered Thames water were able to multiply extensively, even when preserved for some days in a refrigerator.

THE additions to the Zoological Society's Gardens during the past week include a Bittern (*Botaurus stellaris*), European, presented by Lord Ilchester, F.Z.S.; two Hamsters (*Cricetus frumentarius*), British, presented by Miss Pugh; two Alligators (*Alligators mississippiensis*), from Florida, presented by Master Williams; a Common Snipe (*Gallinago cœlestis*), British, purchased.

OUR ASTRONOMICAL COLUMN.

COMET HOLMES (NOVEMBER 6, 1892).—The following is a continuation of Herr Berberich's ephemeris of this comet, the places being for Berlin, midnight:—

	R.A. h. m. s.	Decl. ° ′	Log r.	Log Δ.
Jan. 5	1 8 50	+33 47·9	0·4119	0·3400
6	9 59	46·4		
7	11 8	45·0		
8	12 18	43·7		
9	13 30	42·6	0·4143	0·3516

The comet is now near to and south following β Andromedæ. Reports from various Observatories state that the comet is now very dim.

COMET BROOKS (NOVEMBER 20, 1892).—This comet is now travelling very quickly. The ephemeris for Berlin, midnight, is continued below:—

	R.A. h. m. s.	Decl. ° ′	Log r.	Log Δ.	Br.
Jan. 5	18 29 40	+66 5·4	0·0805	9·8562	7·82
6	19 0 49	13·6			
7	19 31 22	65 59·2			
8	20 0 22	24·6	0·0806	9·8651	7·49
9	20 27 8	64 32·4			
10	20 51 19	+63 26·0	0·0811	9·8781	7·01

The unit of brightness is taken as that at midnight on November 21.

The track of the comet lies near the pole of the ecliptic, in the constellation Draco.

THE SPECTRUM OF COMET HOLMES.—The spectrum of the comet appears to have been continuous without any trace of bright bands. At South Kensington it appeared to have its brightest part near the chief carbon fluting (λ 517), but there was nothing which could be described as a line or fluting. As might be expected, there was a brighter continuous spectrum from the nucleus. The same result was obtained by Mr. Campbell at the Lick Observatory, and by Prof. Keeler at the Allegheny Observatory. The latter observer remarks that the spectrum is just what we should expect if the comet shines entirely by reflected sunlight.

THE RECENT OPPOSITION OF MARS.—In the December number of *Astronomy and Astro-Physics*, Prof. W. H. Pickering summarizes the conclusions derived from the observations of Mars at Arequipa as follows: (1) That the polar caps are clearly distinct in appearance from the cloud formations, and are not to be confounded with them. (2) That clouds undoubtedly exist upon the planet, differing, however, in some respects from those upon the earth, chiefly as regards their density and whiteness. (3) There are two permanently dark regions upon the planet, which under favourable circumstances appear blue, and are presumably due to water. (4) Certain other portions of the surface of the planet are undoubtedly subject to gradual changes of colour, not to be explained by clouds. (5) Excepting the two very dark regions referred to above, all of the shaded regions upon the planet have at times a greenish tint. At other times they appear absolutely colourless. Clearly marked green regions are sometimes seen near the poles. (6) Numerous so-called canals exist upon the planet, substantially as drawn by Prof. Schiaparelli. Some of them are only a few miles in breadth. No striking instances of duplication have been seen at this opposition. (7) Through the shaded regions run certain curved branching dark lines. They are too wide for rivers, but may indicate their courses. (8) Scattered over the surface of the planet, chiefly on the side opposite to the two seas, we have found a large number of minute black points. They occur almost without exception at the junctions of the canals with one another and with the shaded portions of the planet. They range from thirty to one hundred miles in diameter, and in some cases are smaller than the canals in which they are situated. Over forty of them have been discovered, and for convenience we have termed them lakes.

The heights of some of the clouds were found to be not less than twenty miles, and indirect observations have led to the conclusion that the density of the atmosphere of the planet is less than that at the surface of the earth, but probably not as much as ten times less.

Prof. Pickering is of opinion that the opposition of 1894 will be quite as valuable to observers as that of 1892, the distance being but little greater, while the planet will be much farther north, and there is less likelihood of the surface being so much obscured by clouds as during the recent opposition.

GEOGRAPHICAL NOTES

AN interesting illustration of the rapid development of South Africa is given by the recent appointment of a magistrate to reside near Lake Ngami to protect the interests of white traders, and enforce the laws restricting the sale of liquor and ammunition to the natives.

THE January number of the *Geographical Journal*, the new form of the Proceedings of the Royal Geographical Society, contains a paper and map of some importance by Mr. A. P. Harper, descriptive of the central part of the Southern Alps of New Zealand. Government surveyors have been sent for several seasons to map out the glaciers, and an effort is being made by thoroughly exploring and mapping the region to make it the Switzerland of the southern hemisphere in the estimation of tourists, as it is already by virtue of its fine mountain systems.

AN important paper on the physical conditions of the waters of the English Channel is published by Mr. H. N. Dickson in the new number of the *Scottish Geographical Magazine*. He shows how the ebb and flow of the tides in the Channel is affected by the characteristic form of the main feature of the coast-line, viz. bays with the western side running nearly from south to north, turning at a sharp angle, and lying open to the east. The circulation of the water and its temperature were found to be largely determined by these conditions.

MR. COLES gave a successful lecture to young people in the hall of the University of London, on Friday last, covering the first half of his subject, "All the World Over," in a very interesting way. Anecdotes of personal adventure combined with exceptionally fine limelight views of scenery to give a vivid impression of the regions touched upon. The second and last juvenile lecture, under the authority of the Royal Geographical Society, will be given on Friday, January 6, at 4 p.m.

THE Royal Scottish Geographical Society announces a course of educational lectures in continuation of those delivered by Prof. J. Geikie and Dr. H. R. Mill last year. The new course will be on the Geographical Distribution of Animals, by Mr. J. Arthur Thomson, who is at present delivering the Thomson Lectures at Aberdeen. The Society has also provided two special lectures to young people, by Prof. C. G. Knott, on Life in Japan, and by Mr. Graham Kerr on his recent travels in South America.

WE understand that a book of travel in Madagascar and Africa, by Mrs. Colvile, F.R.G.S., describing the observations of the authoress on a recent extensive tour, will shortly be published by Messrs. Blackwood.

MR. J. W. GREGORY, assistant in the Geological Department of the British Museum, has joined as naturalist the sporting expedition of Lieutenant Villiers and others, which is on the point of starting up the Juba. From Bardera, the head of navigation, the party will traverse unknown regions to Lake Rudolf, and from there attempt to cross in a north-easterly direction, through the Galla country and Somaliland to Berbera, on the Gulf of Aden.

THE INTERNATIONAL ZOOLOGICAL CONGRESS AT MOSCOW.

THE International Zoological Congress held its second session in Moscow during the month of August last, and with most commendable zeal the committee, to whose care the editing and publishing of the memoirs read were committed, now publish the first part of the volume of its Proceedings. This part is printed in royal octavo size, and contains 350 pages, with several illustrations. All the memoirs are in French, thirteen out of the total thirty having been translated from, it is presumed, Russian. In the first section—that of questions concerning biology and systematic and faunistic zoology from a general standpoint—there are three papers. J. de Kennel replies to the queries of Prof. L. Cosmovici: (1) On a definite arrangement of the animal kingdom in "Phyla"; (2) is there a type "Vermes"? (3) on a uniform terminology of the secretory organs of worms. Ch. Girard on some points of nomenclature. J. de Bédriaga on introduced species, and on hybrids, reptilian and amphibian. In Section II.—the same subjects from a special standpoint—there are twelve papers:—P. N. Boutchinsky, on the Black Sea fauna; refers to a report on invertebrates of the Bay of Sebastopol by Péréïaslavtzeva, who records 639 forms found. He describes three zones: (1) from the surface to a depth of 175 feet; (2) from 175 to 280 feet in depth, with a minimum temperature of 6–7° C.; and (3) from 280 to 700 feet, with a slightly higher temperature than in the previous zone, 8–9° C. From a depth of 700 feet the water contains a quantity, more or less large, of sulphureted hydrogen, the quantity notably increasing with the depth. T. J. Van-Beneden gives a note on the living and extinct Cetacea of the same sea. Gr. Kojevnikov gives an account of the fauna of the eastern Baltic based on many recent explorations. Dr. J. de Bédriaga treats of European and circum-mediterranean vipers. C. Grévé has a paper on the geographical distribution of the Carnivores, and T. Richard, one on the geographical distribution of the Cladocerous crustacea. H. de Jhéring makes some observations on insects' nests made of clay. Prof. A. Brandt gives a classification of animal variations according to their causation. Prof. A. Milne Edwards and E. L. Bouvier give a most interesting account of the varieties and distribution of *Parapagurus pilosimanus*, S. T. Smith. A table with the comparative measurements of forty-two specimens, is appended. *P. abyssorum* and var. *scaber*, are reduced to the first named species. F. Vejdovsky describes *Thuricola gruberi*, n. sp., and *Monodontophrya longissime*, gen. et sp. nov., the former from a stream near Bodenbach, the latter in the alimentary tract and body cavity of *Rhynchelmis limosella*, Hofm. In a short note Dr. J. de Bédriaga calls attention to some differences between *Chalcides simonyi*, Steind., and *C. viridanus*, which forms Boulenger and Steindacher have proposed to unite, and thinks that *Molge luschani*, Steind., neither belongs to Molge nor to Salamander, but to a European and American genus, not however named by him.

The third section contains eight papers on histology and embryology. N. Kholodovski, contributions to a mesoderm and metamere theory. A. Ptitzine, note on the formation of the germ of the peripheric nervous system. V. Roudnev, note on the development of the cardiac endothelium in Amphibians. Mme. O. Tikhomirova, on the development of *Chrysopa perla*. Fr. Vejdovsky, on the segmentation of the ovum and the formation of the blastoderm in the Pseudo-scorpiones, and on a rudimentary organ in the same. N. Koulaguine, contribution towards the history of the parasitic hymenoptera. A. Tikhomirov, value of embryological research for classification. Section IV., physiology:—C. Khvorostansky, on the luminosity of animals from the White Sea.

In Section V., devoted to morphology and comparative anatomy, L. Cosmovici writes as to the purport of the "aquiferous system," "segmentary organs," "excretory organs," and "nephridia." H. de Jhéring, on the presence or absence of an excretory apparatus in the genital organs of the metazoa. P. Mitrophanov, note on the metameric significance of the cranial nerves. N. Nassonov, on the position of the Strepsiptera in the animal system, according to the facts of post-embryonal development and of anatomy. A. O. Kovalevsky, on the excretory organs of the terrestrial Arthropods. N. Zograf, on the origin and parentage of the Arthropods, more especially the tracheal bearing forms.

A BOTANIST'S VACATION IN THE HAWAIIAN ISLANDS.

THE new number of the American *Botanical Gazette* (vol. xvii., No. 12) contains the first part of a paper by Prof. D. H. Campbell, describing his experiences during a vacation spent last summer in the Hawaiian Islands. We reprint the following passage:—

On awakening upon the seventh day out, and looking through the port-hole of my state-room, I saw that we were sailing near land. Rugged barren looking hills were seen; and, going upon deck, I learned that this was Oahu, the island upon which Honolulu is situated. As we skirted the shore at a distance, I soon spied a grove of unmistakable cocoa palms, the first hint of the tropical vegetation to which I was soon to be introduced. Beyond was the bold promontory of Diamond Head, an extinct volcanic crater, forming a great bowl with rugged sides, right at the water's edge. Beyond this, and bounded partly by it, is the bay upon whose shores stands the city. Back of it rose abruptly a chain of mountains, in places about three thousand feet above sea-level, and furrowed by deep valleys, whose walls, as well as the cloud-capped summits of the hills, were covered with the most wonderfully verdant vegetation. Never before had I realized the possibilities of green. Blue greens, yellow greens, gray greens, and positive greens, with all degrees of these and others that are indescribable, combined to form what Whistler would term a symphony in green.

As if to vie with the colours of the mountains, the sea exhibited an equally wonderful variety of tints. Outside the harbour is a coral reef, and within this the water is of the pale green common to shallow ocean water; but outside it deepens very rapidly into the vivid blue of the open ocean. From a distance the line is clearly seen; but, as the observer approaches shore, the water changes from deep blue through every shade of blue and green until the pale green of the water within the harbour is reached.

As we approached land numbers of the queer outrigger canoes of the natives were met, and from the wharf boys jumped into the water and swam about the ship in the hope of persuading some of the passengers to throw over to them coins, which they were very skilful in diving for.

On the way to the hotel a few gardens were passed, and in them everything was strange. By far the most striking thing was the superb *Poinciana regia*. Although I had never seen this before I recognized it in an instant from a description of Charles Kingsley's, read long ago. Surely in the whole vegetable kingdom there is no more splendid plant. A spreading flat-topped tree, perhaps thirty feet high, with feathery green, acacia-like foliage and immense flat clusters of big flaming scarlet flowers that almost completely hide the leaves so that the tree looks like an immense bouquet. They were in their prime about the time of my arrival in Honolulu, and continued to flower more or less for the next six weeks. Pretty much everything in Honolulu, except the cocoanuts and an occasional haw tree (*Paritium tiliaceum*) is planted; but people seem to vie with each other in seeing how many different kinds of plants they can grow, and the result is that the place is like one great botanical garden. To Dr. Hillebrand this is said to be largely due, as he was one of the first to introduce foreign ornamental plants, and his place, which is kept much as it was at the time he left the islands, was a very remarkable collection of useful and ornamental plants from the warm regions of almost the whole globe.

Probably the first thing that strikes the traveller from the cooler regions is the great variety and number of palms. Of these the beautiful royal palm (*Oreodoxa regia*) is easily first. With its smooth columnar trunk, looking as if it had been turned, encircled with regular ring-shaped leaf-scars, and its crown of plumy green leaves, it well deserves its name. Other characteristic palms are various species of betel palms (Areca), wine palm (Caryota), sugar palm (Arenga), and a great variety of fan-palms of different genera. None is more beautiful than a thrifty young cocoa palm, but unfortunately it is very subject in the Hawaiian Islands to the ravages of some insect which eats the leaves and often renders them brown and unsightly. Indeed, it is almost impossible to find a specimen which is not more or less disfigured by this pest. The trunk of the cocoanut tree is usually more or less crooked, and in old specimens much too tall

for its thickness, so that the old trees look top-heavy. The date palm flourishes in Honolulu, where it is quite dry, but does not do so well in the wetter parts of the islands.

On studying the other trees, one is struck at once by the great preponderance of Leguminosæ, especially Cæsalpineæ and Mimoseæ. All about the town, and growing very rapidly, is the algaroba (*Prosopis juliflora*), a very graceful tree of rapid growth, with fine bipinnate leaves and sweetish yellow pods, which animals are very fond of, and which are used extensively for fodder. Add to this that the tree now forms the principal supply of fuel for Honolulu and we can realize its full value. Other leguminous trees that are planted are the monkey-pod (*Pithecolobium samang*), tamarind, various species of Bauhinia and Cathartocarpus. One species of the latter with great drooping bunches of golden yellow flowers and enormous cylindrical pods three or four feet long, rivals the Poinciana when in full flower.

Mingled with these are a great number of shrubs and trees with showy flowers or leaves, most of them more or less familiar to the stranger, either from pictures or from green-house specimens. Several species of Musa are grown, and when sheltered from the wind are most beautiful; but ordinarily the leaves are torn into rags by the wind. The tall and graceful *M. sapientium* has been largely supplanted by the much less beatiful Chinese banana, *M. Cavendishii*, which is short and stumpy in growth, but enormously prolific. The related traveller's tree (*Ravenala Madagascariensis*), is a common and striking feature of many Hawaiian gardens. Of the many showy flowering shrubs, the beautiful *Hibiscus Rosa-Sinensis* is one of the commonest, and is used extensively for hedges. One of the most striking hedges in the city, however, is the famous one at Puna Hou college, which is 500 feet long and composed of night-blooming cereus. I was not fortunate enough to see this when it was in full flower, but I saw a photograph of it when it was estimated that there were about 8000 flowers at one time.

Of the fruit trees ordinarily grown, the following may be mentioned. The mango is a very handsome tree with dense dark green foliage and masses of yellow and reddish fruit on long hanging stalks. The bread-fruit tree is common, both cultivated and wild, and is a very beautiful tree of moderate size, with leaves looking like immense fig-leaves, and the fruit like a large osage orange. I saw no ripe fruit, and so had not an opportunity of testing its quality. Guavas of different varieties are extremely common, both wild and cultivated, and the various fruits of the whole citrus tribe grow well. The few specimens of temperate fruits were, for the most part, much inferior to those of the United States. Of the fruits that did not strike my fancy, at least at first, was the alligator pear (*Persea gratissima*), a big green or purple pear-shaped fruit with an immense single seed. The pulp is somewhat waxy in consistence and very oily. It is eaten as a salad, and very much relished by the islanders, but the taste is acquired. The curious papaya (*Carica papaya*) is another fruit which did not appeal to my palate. Its big orange fruit, not unlike a melon in appearance when cut open. has a peculiar "squashy" flavour that suggested it having been kept a day too long.

Many showy climbers are planted, some of which, like Stephanotis, Thunbergia and Allamanda are superb; but there is one that is particularly obnoxious in colour, Bougainvillea, whose magenta floral-bracts are an offence to the eye, forming a cataract of raw colour. It looks, as some one observed, as if it had just come from a chemical bath.

As soon as one gets fairly away from the city, it is at once seen that all the luxuriant vegetation is strange. Along the seashore is a plain gradually rising into low hills, both almost destitute of trees, except here and there a few cocoa palms along the shore. Of the strictly littoral plants among the most conspicuous is the curious *Ipomœa pes-capræ*, with deeply two-cleft leaves and purplish pink flowers. In the fertile lowlands near the sea are the principal cane and rice fields, which with taro are the staple crops. The rice is cultivated entirely by Chinese, near Honolulu; but on the sugar plantations the Japanese are largely employed. To see a Chinese laboriously transplanting little handfuls of rice into straight rows, or ploughing in the mud and water with a primitive plough drawn by a queer Chinese buffalo are sights very foreign to an American eye. Sugar cane is eminently productive in the islands, and, hitherto, has proved the main source of revenue; but now the Hawaiians are bewailing the depression caused by the free admission of sugar from other countries into the United States; as, hitherto, their product has enjoyed practically a monopoly of the American market, having been admitted by treaty free of duty.

I made several trips up the valleys back of the city, but owing to the almost constant rain in many of them, these were not always agreeable. However, one is richly repaid by the luxuriance and variety of the vegetation. For a mile or two we pass between grass-covered hills, or hills overgrown in places with the lantana, which, introduced as an ornamental plant, has become a great pest. This plant covers some of the hills with an absolutely impassable thicket, and spreads very rapidly, so that it is a serious problem what is to be done with it. Of the common roadside plants, an orange and yellow milkweed and the showy white *Argemone Mexicana* were the most conspicuous. As one proceeds farther, where more moisture prevails, the variety becomes larger. Thickets of Canna and a Clerodendron with double rosy-white flowers, are common, and the curious screw-pine (*Pandanus odoratissimus*) is occasionally seen. This latter is a very characteristic plant, but is much more abuudant in some of the other islands. In this region some very showy species of Ipomœa are very common, among them the well-known moon-flower, *I. bona-nox*.

With the increase in moisture, as might be expected, the mosses and ferns increase in number and beauty. There are many of them of types quite different from those of the United States. One of the commonest ferns of the lower elevation in *Microlepia tenuifolia*, a very graceful fern with finely divided leaves and terminal sori. Species of Vittaria, with very long undivided leaves, are also common here.

As we ascend one of the commonest ferns is *Sadleria cyatheoides*, a very large fern, often more or less arborescent. Ascending still higher the number and variety of ferns increases rapidly, and many beautiful and interesting ferns and mosses and liverworts become common.

At about one thousand feet elevation we begin to meet with species of Cibotium, to which genus belong the largest of the tree ferns of the islands. Here, also, I met for the first time with the smallest of all the ferns I have ever seen, *Trichomanes pusillum*. This dainty little fern, one of the Hymenophyllaceæ, forms dense mats on rocks and tree-trunks, looking like a delicate moss. The full-grown frond is fan shaped, and, with its stalk, is not more than half an inch high. These tiny leaves, nevertheless, in many cases bore sporangia.

SOCIETIES AND ACADEMIES.

London.

Royal Society, December 8.—"Preliminary Account of the Nephridia and Body Cavity of the Larva of *Palæmonetes varians*." By Edgar J. Allen, B.Sc., University College, London. Communicated by Prof. W. F. R. Weldon, F.R.S.

The Green Gland, in a larva of *Palæmonetes* which is a few days old, consists of an end-sac, which communicates by means of a U-shaped tube with a very short ureter, opening at the base of the second antenna. At the time of hatching, the gland consists of a solid mass of cells, without a lumen. In later stages the tube of the gland enlarges to form the bladder. The enlarged bladders of the two sides subsequently meet and fuse in the middle dorsal line, forming the nephroperitoneal sac described by Weldon and Marchal.

The Shell Gland is found in late embryos and young larvæ of *Palæmonetes*. It consists of a short renal tube, with a considerable lumen, which communicates internally with an end-sac, and opens externally at the base of the second maxilla.

Sections through the anterior region of the thorax of *Palæmonetes* show that the body cavity may be divided into four regions: a *dorsal sac*, surrounded by a definite epithelium, in which the cephalic aorta lies, but which does not itself contain blood; a *central cavity*, containing liver, intestine, and nerve-cord; two *lateral cavities*, containing the proximal ends of the shell glands; and fourthly, the *cavities of the limbs*, which contain the distal ends of the same organs.

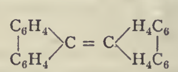
In late embryos of *Palæmonetes* solid masses of cells lie upon either side of the cephalic aorta. The dorsal sac is formed by the hollowing out of these masses of cells. Two lateral cavities are thus formed, which are separated by the aorta. The protoplasm of the cells lining these cavities, which is at first gathered into masses around the nuclei, then spreads out into a thin sheet, drawing away from the lower portion of the aorta, and causing the two lateral cavities to unite ventrally, and so form a single sac.

In the posterior region of the thorax the central and lateral cavities are similar to those of the anterior region, whilst dorsal to them the pericardial chamber lies. This chamber is separated from the central body cavity by the pericardial septum. The genital organs are situated immediately below the front end of this septum.

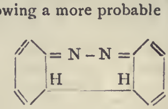
A comparison with the body cavity of *Peripatus* suggests the following relations. In the anterior region of the thorax of *Palæmonetes* the dorsal sac is homologous with the dorsal portions of the mesoblastic somites of *Peripatus*, and its cavity is a true cœlom. The central and lateral cavities, together with the cavities of the legs, represent the pseudocœle. In the posterior region of the thorax the cavities are all pseudocœlomic, and agree with those of the adult *Peripatus*.

December 15.—"Preliminary Note on the Relation of the Ungual Corium to the Periosteum of the Ungual Phalanx." By F. A. Dixey, M.A., M.D., Fellow of Wadham College, Oxford. Communicated by E. A. Schäfer, F.R.S.

Chemical Society, December 1.—Prof. A. Crum Brown, President, in the chair.—The following papers were read:—The isolation of two predicted hydrates of nitric acid, by S. U. Pickering. The author announces the isolation of two crystalline hydrates of nitric acid: the monohydrate and the trihydrate, melting at $-36 \cdot 8°$ and $-18 \cdot 2°$ degrees respectively. In the case of either the melting-point is lowered by the addition of acid or water. The existence of these compounds was foreseen from an examination of the curves plotted from Bertholet and Thomsen's heat of dissolution values. This result is an important confirmation of the author's views.—Anhydrous oxalic acid, by W. W. Fisher. The best method of obtaining crystallized anhydrous oxalic acid is by allowing the hydrated acid to remain in contact with concentrated sulphuric acid for some months in a sealed glass tube. Oxalic acid is soluble in about 30 parts of cold sulphuric acid; the anhydrous acid dissolves with absorption of heat, whilst the reverse is the case with the hydrated acid. Anhydrous oxalic acid may be crystallized from nitric acid of sp. gr. 1·5. Oxalic acid may be completely dehydrated in a vacuum at 60°; the anhydrous acid is soluble in ethyl oxalate or glacial acetic acid, and separates from these solvents in a powdery form.—The production of orcinol and other condensation products from dehydracetic "acid," by N. Collie and W. S. Myers. The authors have obtained orcinol by the action of barium hydrate on dehydracetic "acid" or dimethylpyrone; on boiling a mixture of syrupy caustic soda and dehydracetic "acid," a true carboxylic acid is first produced, and, losing carbonic anhydride, yields orcinol. Among the products of the interaction of barium hydrate and diacetylacetone bright yellow needles melting at 180–181° are found; these probably consist of a naphthalene derivative $C_{14}H_{14}O_3$. Amidodehydracetic "acid," obtained in long needles melting at 192–196°, by the action of strong ammonium hydrate on dehydracetic "acid," readily yields dehydracetic "acid," on acid or alkaline hydrolysis.—Observations on the origin of colour and on fluorescence, by W. N. Hartley. It cannot be stated in general terms that colour is due to special methods of atomic arrangement; the statement may, however, be applied in a restricted sense to certain organic compounds, especially to those included in the class to which organic dye-stuffs belong. It is pointed out that all open chain hydrocarbons exert a continuous absorption, the extent of which depends on the number of carbon atoms in the molecule. The condition of strain and instability existing in many coloured substances has been remarked by Armstrong; the author points out that all organic colouring matters are endothermic compounds, and considers this to be the physical cause of what Armstrong terms "reactivity" or "high potential." It is shown that anthracene is not colourless, but has a true greenish-yellow colour in addition to its fluorescence. A number of experiments on fluorescence are detailed, and the following conclusions drawn from them:—(1) Alcoholic solutions of quinine exhibit a beautiful, bright violet fluorescence. (2) Hydrochloric acid is not fluorescent. (3 and 4) Quinine hydrochloride and chloroform are feebly fluorescent, but without distinct colour. (5) Both hydrochloric acid and chloroform can extinguish those rays which are the cause of fluorescence in quinine. (6) Some alkaloids may be recognized by the degree and colour of their fluorescence. (7) Normal alcohols of the ethylic series and the fatty acids are fluorescent. (8) Glycerol has a violet fluorescence. (9) Benzene has a pale blue fluorescence, azobenzene a greenish-blue. (10) Rock crystal has a pale bluish-violet fluorescence, flint glass a strong blue, and crown glass a very brilliant blue fluorescence. (11) Substances which are not fluorescent in strong solutions may become so on dilution, particularly if they exert a very powerful absorption of the ultra-violet or invisible spectrum.—The origin of colour, v. coloured hydrocarbons and fluorescence: a reply to Prof. Hartley's observations on the origin of colour and of fluorescence, by H. E. Armstrong. If attention be paid to visibly-coloured organic substances, it is a most remarkable fact that in those cases in which the "constitution" is fairly well established coloured substances are found to be all of one type. The author starts from this basis to inquire whether all coloured organic substances are not similar in type. Hartley's remark that all organic colouring matters are endothermic compounds has little importance in the present connection, inasmuch as the converse does not hold. The author contends that before admitting the fluorescence of many substances, *e.g.* alcohol and its homologues, every precaution must be taken to ensure their purity; instances in which easy explanation of the fluorescence of certain substances is possible are given. Hartley's observation that anthracene is coloured strongly confirms the author's hypothesis. Anthracene is fluorescent, and may be represented by a quinonoid formula, whilst its isomeride phenanthrene, which cannot be so represented, is colourless and non-fluorescent. Furthermore, whilst intense colour is produced by "weighting" what the author terms the "quinonoid radicles" of anthracene by replacing the central hydrogen atoms by a halogen, no such effect attends the similar treatment of phenanthrene, dibromophenanthrene being colourless like the hydrocarbon. And yet anthraquinone and phenanthraquinone are coloured yellow and deep orange respectively. Reference is made to other coloured hydrocarbons, viz. carotin and the red hydrocarbon, $C_{26}H_{16}$, recently investigated by Graebe. The formula assigned to the latter by Graebe—



—is an improbable one; such a substance would be colourless. The author gives a possible constitution, and, for the present, proposes to call the compound "erythrophene." The yellow hydrocarbon, $C_{26}H_{16}$, obtained together with this, is possibly a diphenylated anthracene, and may be termed "xanthophene." The "quinonoid radicles" in both hydrocarbons are heavily "weighted," hence their strong colour. With reference to Hartley's statement that a very little shifting of the region of absorption determines the presence or absence of colour in a compound, it is contended that this shifting may be due to a special character of structure. The author then explains his views as to the manner in which the "quinonoid mechanism" conditions colour. He suggests that in quinonoid compounds there are two "colour centres" corresponding to and expressed by the symbol ⊃ in formulæ such as he has used in representing coloured substances. These centres co-operate in producing colour through interaction of the light waves which traverse them. Substances in which there are no such co-operating centres may absorb generally and selectively in "ultra" or "infra" regions of the spectrum, but without exhibiting "visible colour."—The origin of colour, vi. azobenzene, by H. E. Armstrong. Azobenzene, a highly-coloured substance, is generally represented as Ph.N : N.Ph, a formula in disaccord with the author's hypothesis explained in the preceding paper. Moreover, the formulæ usually attributed to the colourless diazo-salts (Ph.N : N.Cl, for example) represent them as comparable in constitution with azobenzene. The behaviour of azobenzene towards bromine and other reagents leads the author to doubt the correctness of the conventional formula assigned to it, and to consider the following a more probable one:—



—The reduction products of dimethyldiacetylpentane, by F. S. Kipping. The author shows that dimethyldiacetylpentane, a diketone produced by the hydrolysis of ethyl dimethyldiacetylpimelate is converted by reduction with sodium in a moist ethereal solution into dimethyldihydroxynonane and a compound

which, judging from the manner in which it is formed, may be regarded as tetramethyldihydroxyheptamethylene.

$$CH_2\left\langle\begin{array}{l}CH_2 \,.\, CHMe \,.\, CMe \,.\, OH \\ \qquad\qquad\qquad\quad | \\ CH_2 \,.\, CHMe \,.\, CMe \,.\, OH\end{array}\right.$$

—The products of the interaction of zinc chloride or sulphuric acid and camphor (third notice), by H. E. Armstrong and F. S. Kipping. The authors have previously shown that the crude product obtained on heating camphor with sulphuric acid or zinc chloride contains 1 : 2 : 4 acetylorthoxylene. On oxidizing the oil remaining after the separation of the latter substance, α-methylglutaric acid is formed. This acid being the characteristic oxidation product of the phorone obtained by distilling calcium camphorate, it is probable that a homologue of this phorone is present in the camphor product.—The Griess-Sandmeyer interactions and Gattermann's modification thereof, by H. E. Armstrong and W. P. Wynne. In employing the Griess-Sandmeyer methods for displacing the amido-group by halogens, the authors find that, in very many cases, much better results may be obtained by operating at relatively low temperatures instead of at the boiling point. It appears also that the Gattermann process affords a larger yield than the Sandmeyer process, only because it is carried out at a lower temperature.—Methods of observing the spectra of easily volatile metals and their salts, and of separating their spectra from those of the alkaline earths, by W. N. Hartley. Persistent flame colourations of easily volatile metals, such as lithium, potassium, rubidium, cæsium, and thallium, may be obtained by heating beads of their fluosilicates, borates or silicates, on platinum wires in the Bunsen flame. If the substance to be spectroscopically examined be converted into a borate, the spectra of the alkali metals may be first observed, and on subsequently passing hydrogen chloride into the flame, the spectra of the alkaline earth metals may be rendered visible.—Manganese borate, its constitution and properties, by W. N. Hartley and H. Ramage. Manganese borate, after drying *in vacuo* over sulphuric acid has the composition $MnH_4(BO_3)_2.H_2O$. On heating at 100° it loses one molecule of water, and at a red heat two molecules more of water are lost, leaving a salt of the composition $Mn(BO_2)_2$. From the rate of loss of water with rise of temperature the existence of a number of intermediate salts is inferred. Manganese borate possesses a maximum of solubility in water at 18°, and a minimum at 80°. This is probably due to dehydration of the compound having the composition $MnH_4(BO_3)_2.H_2O$.

Anthropological Institute, December 13.—Edward B. Tylor, President, in the chair.—Mr. Arthur J. Evans read a paper on the prehistoric interments of the Bahi Rossi caves near Mentone and their relation to the Neolithic cave-burials of the Finalese. He described the recent discovery of three skeletons in the cave of Barma Grande, and showed that the character of the sepulchral rites practised, the relics found, and the racial type of the human remains agreed with the earlier discoveries made by M. Rivière and others in the same caves. Mr. Evans, however, opposed the theories that had been put forward as to the Palæolithic date of "Mentone Man." The bones of extinct Pleistocene animals and implements of the Moustier and Magdalenian types found in the cave earth above the interments proved nothing, for the simple reason that they were interments. No remains of extinct animals had been found in actual juxtaposition with the skeletons. On the other hand the complete absence of pottery, of polished implements, and of bones of domesticated animals in this whole group of interments and the great depth at which they occurred proved that the remains belonged to a very early period. Evidence was here supplied of an earlier Neolithic stage than any yet authenticated. Still the remains belonged to the Later Stone Age and to the days of a recent fauna. Mr. Evans compared some bone ornaments found with the so-called hammer-heads of the chambered barrows of Scandinavia and the decorative system with that found on Neolithic pottery in northern Europe. He further showed that interments of the same tall dolichocephalic race in a more advanced stage of Neolithic culture were to be found in the cave-burials of the Finale district further up the Ligurian Coast. The physical form and the character of the sepulchral rites was essentially the same. Only the skeletons were here associated with polished axes, pottery, and bones of domesticated animals. The direction from which the new civilizing influences had come was indicated by imported shell ornaments from the southern and eastern Mediterranean; in the Mentone caves the imported shells were from the Atlantic. In conclusion Mr. Evans showed that the latter Finale interments exhibited forms of pottery and implements identical with those of the Italian terremare of the other side of the Apennines, and included ceramic shapes which seemed to be the prototypes of vessels found in the early Sikel tombs of Mycenæan age. The Italic culture here revealed fitted on not only to that of the early pile-settlements of the Po Valley and the Lake-dwellings of Switzerland, but might be traced to the Danube valley, to Thrace, and the Troad. Amongst other parallel forms owl-like idols bearing a strong resemblance to those described by Dr. Schliemann from the site of Troy had been found by Padre Morelli of Genoa in one of the Finale caves.—Dr. H. Colley March read a paper in which he sought to prove that the peculiar features of Polynesian ornament are due to a mythography which is, in the main, a symbolism of origin and descent. Thus regarded, unattractive and bewildering designs are resolved into emblems of divinity and demonstrations of lineage. He traced the evolution and defined the attributes of Tiki, explained the nature of oromatuas and the meaning of unus, described the various methods of recording pedigrees, whether along a male or along a female line, and illustrated the mythical use of tapa and sinnet. He discussed, as modes of origin, totemism, gemmation, and generation, of which Polynesian examples were given, tabulated the kinship of the superior gods, set forth in full the Tane cult, especially in relation to the axe and the drum, and endeavoured, in conclusion, to account for the development of the complicated Mangaian adze.

EDINBURGH.

Royal Society, December 5.—Sir Douglas Maclagan, President, in the chair.—After an introductory address by the President, a note by Prof. Cayley, on uniform convergency of series, was read.—Prof. Tait communicated a note by Prof. P. H. Schoute, of Groningen, on the locus of a uniformly revolving line, which always passes through a point moving uniformly round a circle, and which always lies in a normal plane passing through the centre of that circle. The degree of the locus is found by an elegant and very simple method.—Dr. C. Hunter Stewart gave notice of a paper on the further development of Kjeldahl's method of organic analysis. The carbon, as well as the nitrogen, present can be determined by the same analysis in the developed method, and much smaller quantities than formerly of the substance analyzed lead to results as accurate as those previously obtained.—Prof. Tait read a note on the division of space into cubes. He gives a different, and more direct and short, solution by quaternions than that given by him some years ago.

PARIS.

Academy of Sciences, December 26.—M. d'Abbadie in the chair.—Thermal elevation under the influence of injections of soluble microbian products, by MM. Bouchard and Charrin. An elevation of temperature recalling that observed by Koch is produced in a marked degree in tuberculous patients by injections of the toxic substances secreted by the pyocyanic bacillus.—Vessels and clasmocytes of the hyaloid in the frog, by M. Ranvier.—Observations of Holmes's comet (November 6, 1892) made with the great equatorial of the Bordeaux Observatory, by MM. G. Rayet and L. Picart, report by M. Rayet.—Observations of Swift's comet (1892, I.) made with the great equatorial of the Bordeaux Observatory, by MM. G. Rayet, L. Picart and F. Courty, report by M. Rayet.—On the laws of dilatation of fluids at constant volume; coefficients of pressure, by M. E. H. Amagat.—Observations of Holmes's comet, made with the *equatorial coudé* (32 cm.) of the Lyon Observatory, by M. G. Le Cadet.—New experimental researches on the personal equation in transit observations, by M. P. Stroobant.—On conjugate systems and couples of applicable surfaces, by M. A. Petot.—On infinitesimal deformation and Bianchi's associated surfaces, by M. E. Cosserat.—On contiguous surfaces relative to the hypergeometrical series with two variables, by M. Levavasseur.—Test for the convergence of series, by M. A. de Saint-Germain.—Criterion of divisibility by any number, by M. Fontès.—On the motion of a particle in the case of a resistance proportional to the velocity, by M. Elliott.—General form of the law of vibratory motion in an isotropic medium, by M. E. Mercadier.—Employment of springs in the measurement of explosive pressures. If errors due to the inertia of the moving parts of the indicator are to be avoided, the amplitude of the

tracing point must not exceed 1 mm. in the case of pressures used in modern firearms. This necessitates careful reading with a microscope.—On the decrease of temperature of the air with the elevation, by M. Alfred Angot. Experiments conducted on the Eiffel Tower indicate a decrease for each 100 m., between the soil and a height of 160 m., ranging from 0·6° in December to 1·46° in June. Between 160 m. and 302 m. the decrease per 100 m. ranges from 0·64° in February to 0·96° in October. At 300 m. the decrease per 100 m. is on the average 0·5° in winter, 0·6° in autumn, 0·7° in spring, and 0·8° in summer.—On the temperature of the electric arc, by M. J. Violle. From calorimetric measurements made with a portion of the arc light carbon detached from the hottest part during the passage of the current, the temperature of the arc, *i.e.* that of the volatilization of carbon, appears as 3500°, assuming the carbon to have its theoretical specific heat, 0·52, at the higher temperatures. This temperature of volatilization is constant, whatever the power employed.—Remarks on high temperatures and the vaporization of carbon, by M. Berthelot. The vapour tension of carbon is quite appreciable even below volatilization, which involves the reduction of a polymer to the monomolecular state, thus in reality representing a chemical process. Higher temperatures than that of the arc can be attained by purely chemical means, such as the explosive combustion of a mixture of oxygen and cyanogen.—On the equality of velocities of propagation of electric waves in air and along conducting fibres, verified by the example of a large metallic surface, by MM. Ed. Sarasin and L. de la Rive.—On nets of electric conductors; reciprocal properties of two branches, by M. Vaschy.—On the enfeeblement of electromagnetic oscillations with their propagation and their subsidence, by M. A. Perot.—Determination of the coefficients of self-induction by means of electrical oscillations, by M. P. Janet.—Doppler-Fizeau's method, exact and approximate formulæ, evaluation of the error involved, by H. de la Fresnaye.—Magnetic properties of oxygen at different temperatures, by M. P. Curie. A series of measurements with oxygen compressed to 5 and to 18 atmospheres respectively gave identical results at temperatures between 20° and 450°. Within this range, the volume coefficient of specific magnetization of oxygen varied inversely as the absolute temperature. The volume coefficient of magnetization of air at the ordinary pressure and at temperature t is given by $10^6 k_t = 2760 \times T^{-2}$, where T is the absolute temperature.—On the rotatory power of quartz at low temperatures, by MM. Ch. Soret and C. E. Guye.—On the fusion of carbonate of lime, by M. A. Joannis.—Ammoniacal compounds derived from ruthenium sesquichloride, by M. A. Joly.—On an iodo-sulphide of phosphorus, by M. L. Ouvrard.—Action of bismuth on hydrochloric acid, by MM. A. Ditte and R. Metzner.—Action of potash and soda on the oxide of antimony, by M. H. Cormimbœuf.—Relation between the heats of formation and the temperatures of the point of reaction, by M. Maurice Prud'homme.—On the study of the chemical reactions in a liquid mass by the index of refraction, by M. C. Féry.—On a propylamidophenol and its acetyl derivatives, by M. P. Cazeneuve.—Quantitative determination of impurities in the methylenes, by M. Er. Barillot.—Separation of micro-organisms by centrifugal force, by M. R. Lezé.—Loss of nitrogen in manures, by MM. A. Müntz and A. Ch. Girard.—Fermentation of manure, by M. A. Hébert.—Drying-up of marshes in Russia, by M. Venukoff.—Chemical conditions of the action of ferments, by M. J. Effront.—On trichophytia in man, by M. R. Sabouraud.—Evolution of the functions of the stomach, by M. J. Winter.—On the histology of the organs attached to the male apparatus in *Periplaneta orientalis*, by M. P. Blatter.—On the presence of a fossil Araliacea and Pontederiacea in the coarse Parisian limestone, by M. Ed. Bureau.—On a new geological map of the French and Spanish Pyrenees, by MM. Emm. de Margerie and Fr. Schrader.—Differential motion of the ocean and the atmosphere; water tides and air tides, by M. F. de Saintignon.—On the perforation of the basaltic rocks of the Gulf of Aden by shingle; formation of a Giant's Kettle, by M. Jousseaume.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, JANUARY 5.

ROYAL INSTITUTION, at 3.—Astronomy: Sir Robert S. Ball, F.R.S.
LONDON INSTITUTION, at 6.—Jewish Wit and Humour: The Rev. the Chief Rabbi.

SATURDAY, JANUARY 7.

ROYAL INSTITUTION, at 3.—Astronomy: Sir Robert S. Ball, F.R.S.

SUNDAY, JANUARY 8.

SUNDAY LECTURE SOCIETY, at 4.—In Search of Pharaoh—Ancient Egypt: its Temples, Pyramids, Monuments, and Mummies (with Oxy-hydrogen Lantern Illustrations): Whitworth Wallis.

MONDAY, JANUARY 9.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—Qualitative Analysis of Colouring Matters: A. G. Green.—The Proportion of Free Fatty Acids in Oil Cakes: Dr. B. Dyer.—Further Notes on Nitrous Oxide: Watson Smith.
ARISTOTELIAN SOCIETY, at 8.—The Psychology of the Subconscious: A. Boutwood.
LONDON INSTITUTION, at 5.—Social Pictorial Satire (Illustrated): G. du Maurier.

TUESDAY, JANUARY 10.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—A Contribution to the Ethnology of Jersey: Dr Andrew Dunlop.—Points of Contact between Old World Myths and Customs and the Navajo Myth, entitled "The Mountain Chant": Miss A. W. Buckland.

WEDNESDAY, JANUARY 11.

GEOLOGICAL SOCIETY, at 8.—Variolite of the Lleyn and Associated Volcanic Rocks: Miss Raisin. (Communicated by Prof. T. G. Bonney F.R.S.)—On the Petrography of the Island of Capraja: Hamilton Emmons. (Communicated by Sir Archibald Geikie, For.Sec.R.S.

THURSDAY, JANUARY 12.

MATHEMATICAL SOCIETY, at 8.—On the Application of Clifford's Graphs to Ordinary Binary Quantics, 2nd Part, Seminvariants: The President.
INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Experimental Researches on Alternate-Current Transformers: Prof. J. A. Fleming, F.R.S. (Discussion.)
LONDON INSTITUTION, at 6.—Electric Lighting (1) Generation of Electric Currents: Prof. Silvanus Thompson, F.R.S.

FRIDAY, JANUARY 13.

PHYSICAL SOCIETY, at 5.—Upon Science Teaching: F. W. Sanderson.
AMATEUR SCIENTIFIC SOCIETY, at 8. Geology in 1892: A. M. Davies.—Recent Developments in the Metallurgy of Gold: T. K. Rose.

SATURDAY, JANUARY 14.

ROYAL BOTANIC SOCIETY, at 3.45.

CONTENTS.

THURSDAY, JANUARY 12, 1893.

AMERICAN MECHANISM.

Modern Mechanism. Edited by Park Benjamin, LL.B., Ph.D. (London and New York: Macmillan and Co., 1892.)

IN order to appreciate this volume thoroughly, it is necessary in the first instance to consider the reason for its existence. Appleton's "Dictionary of Engineering," an American book, was published in the year 1851, and was the first to gather in cyclopedic form descriptions of products of American mechanical industry. Some thirty years afterwards it became necessary to bring the work up to date, and its complete reconstruction was decided upon. The editor observes that no previous work of a technical character had so signally, and so quickly, demonstrated its own usefulness; it rapidly became a recognized standard of American mechanical practice. Owing, however, to the great progress made in mechanical invention, and the marvellous rapidity with which electrical science has advanced, a new record of the results has become necessary, and hence the present volume.

The list of contributors includes the names of eminent men, well known in this country for their high attainments in the different branches of mechanical and electrical engineering, forming a sure guarantee that the information to be gleaned from the pages is valuable and accurate. It would be impossible in the space at our disposal to notice more than a small part of the contents. Some interesting information is to be found on the subject of aerial navigation, more particularly the interesting experiments being carried out by Mr. Hiram S. Maxim. Commenting on Prof. Langley's statement, that with a flying machine the greater the speed the less would be the power required, Mr. Maxim says: "In navigating the air we may reason as follows: if we make no allowance for skin friction and the resistance of the wires and framework passing through the air—these factors being very small indeed at moderate speeds as compared to the resistance offered by the aëroplane—we may assume that with a plane set at an angle of 1 in 10, and with the whole apparatus weighing 4000 pounds, the push of the screw would have to be 400 pounds. Suppose, now, that the speed should be 30 miles an hour; the energy required from the engine in useful effect on the machine would be 32 horse-power (30 miles = 2640 feet per minute, $\frac{2640 \times 400}{33{,}000} = 32$). Adding 20 per cent. for slip of screw, it would be 38·4 horse-power. Suppose, now, that we should increase the speed of the machine to 60 miles an hour, we could reduce the angle of the plane to 1 in 40, instead of 1 in 10, because the lifting power of a plane has been found to increase in proportion to the square of its velocity. A plane travelling through the air at the rate of 60 miles an hour, placed at an angle of 1 in 40, will lift the same as when placed at 1 in 10, and travelling at half this speed. The push of the screw would therefore have to be only 100 pounds, and it would require 16 horse-power in useful effect to drive the plane. Adding 10 per cent. for the slip of the screw, instead of 20, as for the lower speed, would increase the engine power required to 17·6 horse-power. These figures, of course, make no allowance for any loss by atmospheric friction. Suppose 10 per cent. to be consumed in atmospheric resistance when the complete machine was moving 30 miles an hour, it would then require 42·2 horse-power to drive it. Therefore at 30 miles an hour only 3·84 horse-power would be consumed by atmospheric friction, while with a speed of 60 miles an hour the engine power required to overcome this resistance would increase eightfold, or 30·7 horse-power, which, added to 17·6, would make 48·1 horse-power for 60 miles an hour."

Mr. Maxim goes on to observe that his experiments show that as much as 133 pounds can be carried with the expenditure of 1 horse-power, and under certain conditions as much as 250 pounds. It will be evident, therefore, that the question of motors is all important, and that the total weight per horse-power developed must be as low as possible. It is stated that the greatest force can be obtained from a compound high-pressure steam engine using steam at 200 to 350 pounds pressure, and such engines have been constructed weighing 300 pounds; the horse-power of these engines is not stated.

It will be interesting to watch the outcome of these investigations. They indicate that much information is being accumulated, and that sooner or later a successful aerial machine will be forthcoming.

The question of armour plates has long vexed the soul of the British Admiralty; many very costly trials have been carried out in order to find the most suitable plate for the service. All these data have probably been known in the States, and that country must have benefited by them. Under this heading we find much information in the book, American experiments being quoted and illustrated. Naturally, the Americans wish to make their own plates, and wisely endeavour to do so by rolling only, to do without the heavy expense of forging. These experiments show that the high-carbon nickel Harveyed plate is undoubtedly the best plate ever tested. As a result of these trials, orders have been placed for plates for the cruisers under construction. An excellent full-page engraving is given of the U.S. armoured battle ship *Indiana*, and to judge by the blackness of the smoke she is not using Welsh coal! The article on steam boilers is well written, and very complete, containing much useful information. Among the many types of boilers illustrated there is a good print of the Yarrow torpedo boat boiler. We miss, however, the familiar Thornycroft boiler, and note an American water tube-boiler for fast launches very like the Thornycroft in the arrangement of the tubes.

The boilers for marine purposes are purely of the British type, and there is nothing of importance to note on this subject beyond the many experimental results recorded.

Further on in the book there is an interesting description of railway-car heating. We are told that car-heating, in the usual acceptance of the term, has come to mean the heating of railway cars by the use of steam from the locomotive. This is important, showing as it does the direction in which American railway companies are moving in the solution of a problem at present occupying the best attention of engineers in this country. Gener-

M

ally, we are told, the systems consist of a separate hot-water circulating system in each car, in connection with a heater, fed by steam from the locomotive, by a continuous train pipe running the length of the train, and coupled together between the cars by flexible hose-pipes and universal couplings ; the Sewall steam coupler being generally used. Another important railway necessity is the continuous brake. Under this heading the latest form of Westinghouse quick-action automatic brake is described. In the original design the brake is applied by the engine-driver allowing a little air to escape from the train pipe, lowering the pressure, and thus applying the brake by the automatic action of the triple valves. It is evident that the vehicle next the engine will feel this reduction first, and its triple valve will work before that on the second vehicle, and so on. On trains of ordinary length this very slight difference in time between the brake's application on each vehicle is of little consequence, but when this automatic brake is fitted to a long goods train it becomes a serious matter. The length of a goods train of fifty American cars is 1900 feet, and the brake should act instantaneously to be perfect. The new triple valve is itself designed to discharge air from the train pipe ; so on the driver opening the driver's valve, allowing air to escape to apply the brakes, the reduction of pressure operates the triple valve on the first car ; this lets out more air, and so on through the train, the brake on the last car, 1900 feet away, being operated in 2·5 seconds after that on the first car.

The vacuum automatic brake is not described or illustrated. This brake is now being more and more brought into use. and for general purposes it appears to be simpler and less liable to get out of order than its competitors.

A considerable part of the volume is taken up with the applications of electricity, for lighting and motive power purposes generally. On dynamo electric machinery much has been written and well illustrated. The reader is taken step by step from the rudiments of the subject to its latest applications, from a description of armatures to the arrangements of the field-magnets, then to the varying designs of dynamos, including most of the known machines. The same may be said on the treatment of the electric motors. Under the head of the transmission of power there is more useful information to be found, this being all the more interesting, because of the proposed use of electricity as a means of transmitting some of the power of Niagara to distant towns. There is, however, something wanting under the heading of electrical measuring instruments. The only ones mentioned are Weston's volt and ammeters. At the present time the street tramways of this country are in an uncertain stage as far as motive power is concerned ; horse-power is admittedly expensive ; the steam locomotive seems to have got into disrepute ; the cable and electric traction appear to be struggling for the mastery. It is interesting therefore to read the memoir on electric traction in this volume. The accumulator system is just described, but the overhead cable or trolley system takes up the greater part of the space, so it is safe to assume that the latter is more generally in use, the principle of which is as follows : the current starts from the positive brush of the dynamo, passing out to the main conductor, suspended over the middle of the track, and along this conductor until it reaches the point where the trolley of one of the motor cars is in contact. Here it divides, and a portion passes down through the trolley to the motors, and thence to the rails forming a return lead to the negative brush of the generator. The main portion of the current passes on to feed other cars upon the line in the same manner, each car taking the quantity of current necessary to develop the required power. There are at the present time nearly 500 electric railways in America, and taking the results of twenty-two electric trolley lines, we find that the expenses vary per car mile from 22·99 cents to 7·89 cents, the highest and lowest respectively. A view is given of the electric street railway at Washington, D.C. ; the overhead conductors being not at all unsightly.

On electric welding there is also much information, the Thomson process being very fully described. It consists briefly in completing the electrical circuit through the parts to be welded together, the resistance being sufficient to heat the parts so as to weld them, this being assisted by pressure.

The Bernado process is not described ; in this process the work to be welded is connected to one terminal of the dynamo. The positive terminal being connected with a carbon rod, held in a portable insulated holder, the carbon rod is then placed on the work, and immediately withdrawn slightly, thus forming an arc, where the metal melts, and with skill much can be done.

The locomotive practice in America has long been of interest to locomotive engineers in this country, owing to the many differences in design and practice. A very good *résumé* of American practice is to be found in the memoir under this heading. A useful table is given showing a few leading dimensions, weights, &c., of typical engines in use. Take, for instance, the express passenger engine, a four-coupled bogie engine, the cylinders being 20 inches in diameter and 24 inches stroke. The driving or coupled wheels are 72 to 78 inches in diameter. The weight on coupled wheels is 75,000 pounds (33·48 tons), the total weight of the engine being 116,000 pounds (51·78 tons), and that of the tender 72,000 pounds (32·14 tons. Comparing these data, we find that the American engine is heavier than an 18×26 cylinder British engine and not so powerful, assuming equal steam pressures ; the tender is light in a similar comparison, probably carrying less water. The reputed weight of trains hauled given in the table is of little use, because the speeds are not given, and for this reason comparisons cannot be made.

The paragraph on locomotive boiler construction is far too short ; many interesting details might have been added. It is stated that the circular smoke-box tube plate is a conspicuous difference between the practices of the two countries, being purely American, whereas the Midland Railway Company have, amongst others, used the arrangement for some time. Owing to the enforced use of anthracite coal in certain parts, many peculiar designs of locomotive boilers have been used, the Wootten boiler being probably the most common. All, however, have particularly large grate areas, which, in the case of the Wootten, may in some cases exceed 76 square feet, or four times the area of the grate of.

recent British engines. An illustration is given of an engine of this type, as well as a full-page engraving of a compound locomotive with a similar boiler. This compound is very different from the Webb or Worsdell engines common in this country, being the design of the superintendent of the Baldwin Locomotive Works. The cylinders are outside the frames—there are two on each side, viz. one high-pressure and one low-pressure. The distribution of the steam being effected in each pair by one piston valve, each pair of pistons is connected to one crosshead, coupled in the usual way to the wheels.

A compound engine of the "Webb" type is also illustrated. This engine was constructed to Mr. Webb's designs in this country for the Pennsylvania Railway in 1889. It is stated that the results of experiments showed a saving of fuel over the ordinary engine of from 20 to 25 per cent.

This book is so full of interesting matter of so varied a nature that it would be possible to prolong this notice far beyond the space available. Take, for instance, agricultural machinery; the Price ploughing outfit is typical of the rest, consisting of a traction engine drawing four gangs of three ploughs, the twelve ploughs cutting eleven feet wide. The subject of milling tools is also of interest, because it is only during the last few years British engineers have used this means of shaping metals, the system having been brought into general use in the States.

Under the head of the manufacture of steel all the usual processes are described. We are informed that the Whitworth compression process is only partly successful in the formation of sound ingots; with this statement we cannot agree; the Whitworth steel ingot after compression is certainly sound throughout.

Taking into consideration the great mass of information contained in the 900 odd pages of this work, and the general excellence of the matter accumulated, it is only just to congratulate the editor on the completion of a work which must prove useful to many, and which should find a place in all technical libraries. The volume goes far to describe modern American mechanism, exhibiting the latest progress in machines, motors, and the transmission of power.

SEEDLINGS.

A Contribution to our Knowledge of Seedlings. By the Right Hon. Sir John Lubbock, Bart., M.P., F.R.S., D.C.L., LL.D., with 684 figures in text. In two volumes. (London: Kegan Paul, Trench, Trübner and Co., Ltd., 1892.)

SEEDS and seedlings have occupied the attention of Sir John Lubbock for a somewhat lengthened period. They have formed the subject of various communications, on his part, to the Journal of the Linnean Society and other publications. In the present volumes, modestly styled a "contribution," he gives us the details upon which his inferences have been founded.

The physical and chemical aspects of germination are entirely passed over, but the morphological phenomena are treated with a fulness never before attempted. The author has availed himself of the resources put at his disposal by the authorities at Kew, where the larger proportion of the seedlings described were grown expressly for the purpose. The Natural History Museum and the Cambridge Botanic Gardens have also been requisitioned, and much help has been rendered by capable assistants, whilst the services of Sir Joseph Hooker and Mr. Rendle, in looking over the proof sheets, are duly acknowledged. A work of such dimensions, crowded with detail, could hardly have been produced without such zealous co-operation. Nevertheless unity of plan and uniformity of treatment are conspicuous throughout, and thus comparison is readily effected.

Some previously published papers in the Journal of the Linnean Society, dealing with the causes which determine the form of leaves and cotyledons, are reprinted as the introduction to the treatise. The conclusion therein arrived at is that the form of the embryo, and especially that of the cotyledons, is essentially influenced by the form of the seed. On p. 78 the author begins the detailed examination of seedlings taken from almost all the orders of flowering plants. Five hundred and thirty succeeding pages in the first volume, and five hundred and eighty-eight in the second volume, are thus occupied. This little bit of statistics will serve to show the amount of detail which is contained within these volumes. The plan adopted is to give, first of all, a general sketch of the principal modifications exhibited by the fruit and seed in each order. Then follows a more detailed description of the seed and of the seedling plant in various representatives of the order. As these descriptions are identical in plan throughout, they are of great value to the student of comparative morphology. Naturally some orders are much better represented than others, but sometimes the omissions are rather unfortunate. In the genus Araucaria, for instance, seedling representatives of which are common in botanic gardens and nurseries, the diversities in the form of the seedling and in the mode of germination are very remarkable. "Characters" derived from the seedling plant have been recognized as of the highest importance for classificatory purposes since the time of John Ray (1682–1703).[1]

But whilst this is generally the case, such extraordinary exceptions as that mentioned in Araucaria are very noteworthy, and not less so because the genus in question is one of the very oldest of which fossil botanists have cognizance.

Myrtaceæ and Sapindaceæ are remarkable for the extremely diverse character of the embryo in different genera, and of which due note is taken in Sir John Lubbock's book. In Rosaceæ, on the other hand, the diversity is much less, nor is there any important morphological difference in the seedlings of the great order Compositæ, and scarcely more in Umbelliferæ, so far as they are known. These are facts of great significance with reference to the theories of inheritance and relative antiquity of groups.

[1] It may not be without interest to cite what Ray says on this matter:—"Floriferas dividemus in *dicotyledones* quarum semina sata binis foliis anomalis, seminalibus dictis, quæ cotyledonum usum præstant, e terra exeunt vel in binos saltem lobos dividuntur, quamvis eos supra terram foliorum specie non efferant; et *monocotyledones* quæ nec folia seminalia bina efferunt nec lobos binos condunt." Thus Ray not only recognized the presence of one or of two cotyledons, but also their nature and their epi- or hypogeal condition. As Ray has been mentioned, it is certainly not inappropriate to allude to Grew also, for the first chapter of his "Anatomy of Plants" (1682). and the whole of the fourth book is devoted to the seeds and seedlings and in perusing them the reader will perceive that Sir John Lubbock has in a few cases been anticipated by his celebrated predecessor.

The gradual evolution of the perfect plant from the seedling is indeed a subject of great interest to the phylogenist, although it is difficult—nay, impossible—to separate those appearances which are merely hereditary from those which are the result of varying outward conditions, the more so because analogous conditions must have influenced the ancestors in past times even as they affect their successors now.

Amid such a mass of detail it is difficult to pick out points worthy of special note. We select two only out of many scores that might be mentioned. Some Onagrads are remarkable for the intercalary growth which takes place in the cotyledons, of which several illustrations are given in Sir John Lubbock's book. They call to mind the experiments of the late Prof. Dickie, who, by suppressing the plumule of seedling castor-oil plants, succeeded in inducing the cotyledons to continue their growth and to assume dimensions much greater than that which is habitual to them.

The small tubercles on the root of *Myrica californica* (vol. ii. p. 523, Fig. 663) have, so far as we know, not previously been observed. The author compares them to those found on *Alnus cordifolia*, and it would be interesting to ascertain whether these outgrowths are caused by an organism analogous to *Schinzia alni*, as described by Woronin, or to that which induces the peculiar tubercles on the roots of Leguminosæ, recently studied by Prof. Marshall Ward.

Monocotyledons generally have been rather badly treated by the author, although such genera as Potamogeton, Aponogeton, Orontium, and other Aroids, and Palms (of which not a single illustration is given) would have furnished examples at once interesting and easily accessible.

The work includes nearly seven hundred illustrations, faithfully executed, and very valuable to the student. The bibliography, in spite of its occupying no fewer than thirty-eight pages, is the weak part of the book. Some of the most important references are omitted, and whole series of species whose mode of germination has been recorded and sometimes figured, have been passed over. This only shows how colossal has been the task which Sir John Lubbock has set himself. We do not think the worse of the sun for having a few spots on his disc, nor are botanists at all likely to disparage this work because further research might have added a few more illustrations. As it is, it forms one of the most substantial and important contributions to botanical literature that have ever emanated from the press. It must continue to be a standard book of reference for generations, and it will, we hope, stimulate observers, according to their several opportunities, to prepare similar monographs on the various organs of plants.

MAXWELL T. MASTERS.

EPIDEMIC INFLUENZA.

Epidemic Influenza: a Study in Comparative Statistics. By F. A. Dixey, M.A., M.D. (London: Henry Frowde and H. K. Lewis, 1892.)

AFTER an epidemic disease has visited a country, when the pathologist and practical physician have had their say, there still remains the work of the statistician to be done. It is his province to sum up the results of the visitation in the clear light of hard figures, and to trace its onset and decline in mathematical curves. Such work is of value in more than one direction. It preserves for future generations a definite record of an epidemic of greater precision than the impression left on the mind of the physician: it enables a comparison to be drawn between our own experience and that of other countries: by the sifting and sorting of facts which it necessitates it may lead to the discovery of relationships with allied diseases which may prove of no small value to the pathologist.

This work has been done for influenza by Dr. Dixey in a very thorough and painstaking manner from the material collected under the supervision of the Registrar-General. It says much for the completeness of our registration system in London, that it is possible to compile from them such tables and curves as those with which we are presented in this work, nor are such materials available from any other city in Europe. The only cities whose statistics have been found by Dr. Dixey sufficiently accurate for comparison with our own are Paris and Berlin.

Dealing first with the epidemic of 1889–90, he shows in Table 1 the rise and progress of the disease in London, as indicated by the weekly returns of fatal cases, grouped according to the seven age periods adopted in the official returns. Table 2 gives us, so far as the returns of the period permit, the similar figures for the epidemic of 1847–48. The similar characters of the two epidemics are strikingly illustrated: in both we see the same extreme suddenness of rise, and the same features of decline, rapid at first, but becoming gradually slower during the succeeding months. In the next two tables are included similar figures for Paris and Berlin, and in these, and in Table 5, the author gives an analysis of the meteorological conditions accompanying the rise and fall of the epidemic in the three cities. These are of interest as showing how little influence the weather had on the course of the disease as a whole.

In the tables which follow—which are perhaps of greater interest than any of the others Dr. Dixey has compiled—the effects which influenza has exerted on the mortality from other diseases in London and other cities are shown. These effects are of two kinds: influenza may aggravate the mortality of pre-existent disease such as phthisis or heart disease, or diseases such as bronchitis or pneumonia may occur as complications of influenza and swell its death-roll. It is interesting to observe that whereas in 1847–48, which was in all respects a more fatal epidemic than that through which we have just passed, bronchitis showed the most extreme departure from the normal mortality, pneumonia holds that place in the late epidemic, while bronchitis falls into the second rank. In this connection may be mentioned a point of much interest illustrated in Tables 10, 11, and 12, which deal with the age incidence of influenza and its concomitant diseases. It is possible to draw curves showing the special age incidence of each, and each curve has its own special features. Now during an influenza epidemic the pneumonia curve is found to be modified so as to take on some of the characters of the influenza curve, thus affording corroborative evidence of a conclusion already reached both in this country and in

Germany, that influenza may occur sometimes as an apparently primary pneumonia.

The remaining tables deal with the data afforded by the epidemics of 1891 and 1892 in this country and abroad. That of 1891 is shown to have been much more fatal, especially at advanced periods of life, than that of 1890, while that of 1892, here treated of with less fulness than the preceding, seems to have been of still greater severity. Those who would follow Dr. Dixey into the details of these outbreaks must study the work for themselves. It is a contribution to statistical literature of very great value, and will save an infinity of labour to those engaged in the study of influenza.

A word of praise must be bestowed in conclusion upon the graphic charts with which the tables have been illustrated, those in particular which deal with the mortality curves from influenza and its allied diseases. These have been calculated and mapped out as percentage deviations from the mean, and show the main facts at a glance in a way which mere columns of figures fail to do. Those also which illustrate the age incidence of the diseases in question are of great value.

OUR BOOK SHELF.

An Elementary Text-Book of Hygiene. By H. Rowland Wakefield. (London: Blackie and Son, 1892.)

THE appearance of yet another elementary text-book upon the subject of Hygiene has the effect of aggravating the *embarras de richesses* which already obtains in this department of study; one is therefore justified in questioning the utility of the present volume, and on reading in the preface that it is adapted to the requirements of the Science and Art Department, there is all the more matter for surprise at its appearance in the face of three other publications—each better than the present—which have been written to meet the same end.

The manual is well printed and concisely written, and a surprising amount of matter is condensed within its tiny compass. This latter fact, however, is not entirely a matter for congratulation, for apart from making the book "dry reading," it must have the effect of rendering it in many places difficult of comprehension to those for whom it is intended, *i.e.* those who approach the subject with no prior knowledge whatever.

And thus it comes about, that in less than 200 small pages the whole range of Hygiene is surveyed, including chapters upon Eyes and Sight, School Hygiene, House Sanitation, Personal Hygiene, Parasites, Infectious Diseases, Accidents and Injuries.

Though the material given has been on the whole well selected and carefully compiled, the work is a little uneven; one finds seventy-three pages devoted to "food," whereas "water" is dismissed in seventeen, and "sewage and its removal" in eleven.

Here and there is evidence of the fact that the author is not of the profession to which Hygiene holds a filial relation, and that he was not quite at home with some of the departments of the subject—even in their elementary form—which he had set himself the task of handling; the very few errors and ambiguities which this fact is accountable for, are, however, too trivial to much affect the general accuracy of the book.

The small work will doubtless suffice for the examination requirements of those for whom it is intended, but the brevity and superficiality of treatment which is so frequently apparent within its pages, will not justify one in recommending it to those who wish to lay a good and useful foundation for a study of the science of Hygiene.

Ostwald's Klassiker der Exakten Wissenschaften. Nos. 38–40. (Leipzig: W. Engelmann.)

WE are glad to note the addition of three volumes to this admirable series. No. 38 is the second part of the original account of the photochemical researches of R. Bunsen and H. E. Roscoe (1855–59). The other volumes are translations of a paper by Pasteur on the minute organic bodies in the atmosphere (1862), and of papers by Lavoisier and Laplace on heat (1780 and 1784). In all the volumes there are figures in the text.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Geographical Names.

As the names of places given to the public with the authority of the Geographical Society of London are very apt to be accepted by geographers and be ultimately inserted in atlases and works on geography, I have to call attention to the paragraph "Nomenclature of the Karakoram Peaks," under "Geographical Notes," p. 857, in the December number of the Proceedings of the R.G.S., 1892, which I have lately read. It is to be regretted that so much reliance and importance has been placed on what a native drew on the sand, and the names he gave to various peaks. Natives are not always to be depended upon, not even when the topographical features are in sight, and unless verified from other and independent information, the names they give cannot be implicitly trusted and placed on record, as is so well exemplified in this case. The traveller must also have a considerable knowledge of the native languages or he may be very much misled. As fortunately I know both the places bearing the names given for two very conspicuous peaks, it may not be too late to prevent these names thus put forward from being accepted and perpetuated. "Skeenmung" or "Skinmang" is the name of a comparatively level piece of somewhat grassy ground at the great bifurcation of the Punmah Glacier, the name itself is expressive and is derived from "*Skeen*" an ibex, and "*Mang*," a level place in Balti = *Marg*, Kashmiri, *Maidan* Hindustani—which disposes of it as a likely designation for a peak.

Next we have "Chiring" given as the name of K2, the second highest peak in the Himalayas, quite as inaccurate, for it happens to be the name of another camping spot or bivouac at the end of a spur and about halfway between Skeenmang and the Mustakh pass, as used about the period I was there (1860). It is situated just above a very narrow part of the glacier, where its action is most marked on the rocky sides. "*Chirna*" in Hindustani is to rend, tear, and Chiring Gause is the name of all that portion extending six miles up to the main watershed.

H. H. GODWIN-AUSTEN.

Shalford Park, Guildford, January 7.

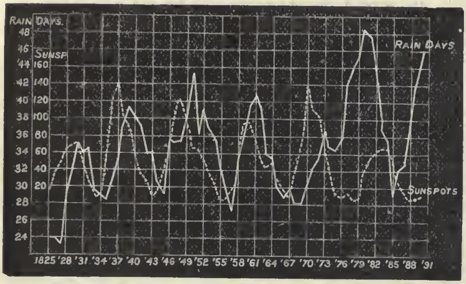
The Weather of Summer.

THE number of days with rain, in summer, at Greenwich, during most of this century, has been subject to a pretty regular fluctuation. The curve (from 1825) having been smoothed by means of five-year averages, we obtain that shown in the diagram. And putting with it a curve of sun-spots, we find a strikingly definite correspondence (somewhat "lagging" in character) throughout at least four of the sun-spot cycles, the rain day maxima coming soon after the sun-spot maxima, and rain day minima soon after sun-spot minima. In recent years, however, the curves appear to have got out of step (so to speak) with each other; so that, *e.g.* we find a rain day *maximum* in 1880, two years after the sun-spot *minimum* of 1878, and a rain day *minimum* in 1885, two years after the sun-spot *maximum* of 1883.

I do not remember to have seen the facts of our summer weather put in this way. But it is well known that, in the discussions which arose some time ago about sun-spots and rainfall, there appeared some reason to believe that in the period of

those four earlier sun-spot cycles, at least, we had had, on the whole, wetter years about sun-spot maxima than about the minima. A good deal was written on the subject (as your own columns show) in the seventies; and the data used seem to have been generally those of annual rainfall. Of late, apparently, the matter has attracted less notice; for the reason (I suppose) that the correspondence referred to has not been maintained, and recent facts have seemed rather against the theory of a causal relation between the two orders of phenomena.

Thus the teaching of the curve here given appears to harmonize, in general, with known facts about annual rainfall. I do not propose to try and weigh the data so far as they may be considered to favour the theory just indicated (earlier and greater part of the curve), nor the data which may be considered adverse (in the short, later part). It seems to me that the curve may be usefully studied *per se*, apart from any relation to sun-spots. Thus we might note the fact that all those maxima where our summers have got to a turning point from wet to dry have been quite near the beginnings of the decades. The dates are 1830, 1839, 1850, 1861, and 1880. The curve ends at 1890 (the final point representing, of course, 1888–92), and the position of this point, together with the date, seem to warrant our



Smoothed curve of rain days in Summer at Greenwich, with curve of Sun-spots.

looking for an early descent of the curve, and a commencing series of (on the average) drier summers than we have had lately.

We might also note that the minima of the curve have ranged from the fives to the eights. Thus we have, 1827, 1835, 1845, 1857, 1868, 1885. Should the recurrence continue, we might look for the next minimum about 1895–1898. Of course there may be difference of opinion as to the strength of the presumption here afforded for such a forecast, and no good reason is offered (beyond experience) why the curve should now take the course roughly indicated.

It is not at variance with the above view that there is reason, it would appear, to anticipate soon a series of wetter *years*. In an article contributed to the *Times* of October 22 last year (cited in NATURE, vol. xliv. p. 630) Mr. Symons says: "There is no doubt that since 1887, at all events, the rainfall over England has been much below the average; and a consideration of all the facts leads to the conclusion that such a period of scarcity is very likely to be followed by one of abundance, and that the coming few years will probably be more rainy than those recently experienced, although possibly the increase will not occur in the summer months—at a time when it would be most noticed."

A. B. M.

"Aminol."

MY attention has only now been called to the letter of Dr. Klein, which appeared in NATURE, *ante*, p. 149.

To the remarks referring to "Aminol" (with Periodate I am in no way concerned) I desire, with your kind permission, to make the following reply, as they contain inaccuracies which, if not corrected, must do me injury.

The samples of "Aminol" alluded to by Dr. Klein were sent by me to a number of medical practitioners who had kindly consented to give it a trial. The strength of the samples was 1 in 5000.

Dr. Klein has carried out between September, 1890, and March, 1891, five separate consecutive series of experiments with "Aminol," with the object of testing its applicability to the treatment of certain external disease processes. His results are recorded in a report, the summary and conclusions of which were published last year with his full approval. The strength of solution employed in the first four series (which were only of a tentative nature with a view to arrive at a proper strength of solution for practical application) was 1 in 6000; in the fifth series a solution of the strength of 1 in 600 was used. Dr. Klein's letter leads one to suppose that he operated only with the latter strength.

The pathogenic germs selected for testing the power of the disinfectant were: spores of *Bacillus anthracis*, sporeless *Bacillus anthracis*, *Staphylococcus aureus*, *Bacillus diphtheriæ*, and *Streptococcus erysipelatis*. Amongst the results obtained with the solution of the strength of 1 in 6000 his report mentions the following: In Series IV., "On *Staphylococcus aureus*, which may be taken as the most resistant microbe amongst those associated with surgical and other external disease processes, the "Aminol" solution (1 in 6000) did produce an effect, though a limited one, after two hours already, and after twenty-four hours destroyed the microbes." In Series I.: "'Aminol' solution (1 in 6000) kills the *Bacillus diphtheriæ* in two hours. This was confirmed in Series III." In this connection it deserves to be noted that I possess already ample evidence, which will be published in due course, of conspicuous successes obtained in practice not only with the solution of the strength of 1 in 5000, but also with dilutions of the same, even to 1 in 20,000.

Dr. Klein's statement of the results which he obtained with "Aminol" in the strength of 1 in 600 is misleading. He says: "Spores of *Anthrax bacilli* remained unaffected after eight hours, only after an exposure of twenty-four hours did the number of living spores decrease; but some escaped disinfection even after so long an exposure. Now what are the facts? I quote from Dr. Klein's report:—

"Spores of *Bacillus anthracis* after 1, 2, 8, and 12 hours	good growth.
"Spores of *Bacillus anthracis* after 24 hours	growth reduced from 100 to 6."

Is it putting the case fairly or even clearly, seeing that no tests were made between twelve and twenty-four hours, to say "only after twenty-four hours did the number decrease," and seeing that only 6 per cent. remained after twenty-four hours? Is not that a decrease practically amounting to disinfection? Would it be extravagant to assume that the insignificant percentage remaining would be eliminated after a very little longer exposure (say another hour), and is there any doubt that a solution of the strength of 1 in 500 or 1 in 400 would have accomplished complete disinfection in a much shorter time than twenty-four hours? But in order to illustrate the significance of the results actually obtained with this solution of the strength of 1 in 600, let us see which other disinfectants can kill anthrax spores in twenty-four hours. I quote from "Koch on Disinfection," abstracted and translated by Whitelegge, published by the New Sydenham Society:—

(1) "For practical purposes a disinfectant should not require much longer than twenty-four hours."

(2) "Except chlorine, bromine, and iodine, only mercuric chloride, osmic acid, and potassic permanganate (5 per cent.) destroyed anthrax spores within twenty-four hours. Since a 5 per cent. solution of permanganate is inadmissible for disinfection in bulk, and osmic acid is out of the question, we have left only mercuric chloride and iodine, bromine, and chlorine."

The strengths in which the above-named substances succeeded in destroying anthrax spores in twenty-four hours are stated in Koch's tables thus:—

Permanganate,	aqueous solution	5 per cent	(1 in 20).
Bromine	,,	2 ,,	(1 in 50).
Chlorine	,,	?	
Iodine	,,	?	
Mercuric chloride	,,	1 per cent	(1 in 100).
Osmic acid	,,	1 ,,	(1 in 100).

Now put against this the fact, quoted above, that Dr. Klein found "that 'Aminol,' strength 1 in 600, killed 94 per cent. of anthrax spores in twenty-four hours," and further (I am quoting his report again), "that this solution is a perfectly harmless fluid as regards the human organism; therefore no undesirable disturb-

ances could ensue owing to its being absorbed; this is well known to be the fact with some antiseptics, as in carbolic acid applications or in the use of perchloride of mercury."

Does not all this clearly establish the claim of "Aminol" to be called not only a true disinfectant, but a most potent and a most safe one at the same time?

But with all this (I mean what relates to its effect on anthrax spores) its application in medical and surgical practice has nothing to do, unless it be to demonstrate its comparative potency, for, as Dr. Klein himself points out in his report, "The spores of *Bacillus anthracis* may be left out of consideration, as they do not occur in the living body; under these conditions the *Bacillus anthracis* is always sporeless; a malignant carbuncle of the skin contains the *Bacillus anthracis* only in the sporeless state, and in infection with anthrax generally the bacilli are always in the sporefree state both in the blood and in the tissues."

What is of real importance in practice is the effect of "Aminol" on the other pathogenic germs on which Dr. Klein has tested it. And here again his letter states the case in a manner which is apt to mislead: "*Anthrax bacilli, Staphylococcus aureus* and others were destroyed, but only after a lengthy exposure."

Now what does his report say? "Series V. From this series it will be seen, therefore, that the solution used in the same (1 in 600) acted very differently from that used in the previous experiments (1 in 6000) inasmuch as the *Staphylococcus aureus*, which was not killed heretofore in eight hours, was in this instance completely disinfected in that time, and was considerably reduced even in one hour. The sporeless *Bacillus anthracis*, *Bacillus diphtheriæ*, and *Streptococcus erysipelatis* were killed in one hour." Can it be fairly said, then, that these were killed only after lengthy exposure, and does the word "only" apply at all to the one-hour results, when it is considered that there was no test made under the one hour? What is there to show that those of which there was no growth after one hour's exposure to the disinfectant had not been killed after ten minutes already?

Does it not look, then, as if Dr. Klein had penned his letter without consulting either his notes or his report?

A word in conclusion. Dr. Klein, for whom perhaps nobody entertains a higher personal regard than myself, may rest assured that the designation, "a true disinfectant," is meant by me to apply only to such strengths of solutions of "Aminol" as can compete with those substances and their respective strengths to which Koch has accorded that appellation. Nor need he to apprehend that anything has been or will ever be done by me intentionally committing him to what is not fully warranted by his actual results as recorded in his authorized published report. HUGO WOLLHEIM.

101, Leadenhall Street, E.C., January 2.

THE point at issue between Mr. Wollheim and myself is a very simple one, and needs no long explanation on behalf of Mr. Wollheim. As you will see from the letter which you kindly printed in NATURE, *ante*, p. 149, Mr. Wollheim, without my authority, has sent round a leaflet with my name on it, accompanying bottles of "Aminol," stated to be "a true disinfectant."

1. On this leaflet my name is introduced in a somewhat misleading manner, for it quotes to a large extent from my reports on the lime and brine experiments on microbes without saying so, but leaving the reader to infer that these reports of mine refer to "Aminol."

2. Mr. Wollheim never asked my permission or informed me of his intention of sending with each sample bottle of "Aminol" such a leaflet. It is unnecessary to say that had he asked me whether he could use my name on a wrapper of a patent medicine I should have emphatically answered *no*. He has recently informed me that he has cancelled the leaflet.

3. The samples of "Aminol" sent out were of the strength of 1 in 5000, the experiments in which I showed that "Aminol" possesses a certain disinfecting power were made with a strength of 1 in 600. This strength did not kill spores of anthrax in 12 hours; 1 in 6000 did not kill *Staphylococcus aureus* in 8 hours.

A substance which, like the "Aminol" sent out (viz. 1 in 5000), cannot kill *Staphylococcus aureus* in 8 hours, and has practically no effect on spores of *Bacillus anthracis* cannot be considered "a true disinfectant."

To show that Mr. Wollheim had a very strange idea about the whole matter, one has only to compare the actual facts of the case, as regards "Aminol" of the strength of 1 in 5000, with the motto put on the leaflet and the inscription on the label of the samples. For Mr. Wollheim quotes Koch to the effect that no disinfectant can be called a true disinfectant that does not kill spores, and notwithstanding that I have shown that "Aminol" even of the strength of 1 in 600 cannot kill spores in 12 hours, yet Mr. Wollheim advertises the "Aminol" of the strength of 1 in 5000 as "a true disinfectant." A true disinfectant kills spores after short exposure; a substance that requires many hours to do so cannot claim the name of a specific disinfectant. Vinegar, dilute acids, alkalies, and a host of substances affect spores after exposure for many hours (8, 12, and 24 hours), yet no one would consider these substances as specific disinfectants.

Again, a substance used in a certain strength (say 1 in 600) may have considerable disinfecting power on non-spore bearing microbes, with or without having any conspicuous action on spores. The same substance more diluted (say 1 in 5000) may have retained such action only to a very insignificant degree. Take for instance perchloride of mercury; while this substance is a powerful disinfectant when used in the strength of 1 in 500, 1 in 1000, even 1 in 2000, it has greatly less effect when used in more increased dilution.

No one is justified in advertising perchloride of mercury of the strength of 1 in 100,000 as "a true disinfectant," knowing that 1 in 500 or 1 in 1000 only can be so called. How much more does this hold good for a substance like "Aminol," which even in the strength of 1 in 600 does not kill the spores of anthrax in 12 hours, a period which for practical purposes of disinfection is out of the question. E. KLEIN.

19, Earl's Court Square, S.W., January 9.

Super-abundant Rain.

IN NATURE of November 10 the fact that "very nearly one-third" of the annual rainfall fell in one month at Nant-y-Glyn, in North Wales, is recorded as "remarkable."

But at Peshawar, on the north-west frontier of India, we received during last August a rainfall of 17·75 inches, the average local annual fall, calculated from the last fifteen years, being 13·51 inches.

We therefore had very nearly sixteen months fall in one month, and by far the largest portion of this fell in ten days of the month.

I need hardly add that the whole valley was flooded, and that we have since paid for our super-abundant rain in the form of very prevalent and fatal malarious fever. H. COLLETT.

Peshawar, December 19, 1892.

Earthquake Shocks.

THERE were two unmistakable shocks of earthquake on the afternoon of Tuesday, January 3, the first at 2h. 15m. 15s. G.M.T., and the second at 2h. 17m. I was sitting in a railway carriage at Severn Junction Station waiting for the Bristol passengers, when I felt a sensible upward movement of the seat (as if pushed from below) and saw the carriage sway. The movement was from south to north (*i.e.* at right angles to the railway). This was repeated four times in about six seconds. At 2h. 17m. there were two more (less strong) shocks. The carriage was placed in a siding, and there was no train at the station, and the air was calm and frosty. Ice was said to have cracked near here at this time. E. J. LOWE.

Shirenewton Hall, Chepstow.

A Brilliant Meteor.

ON Wednesday, January 7, at about 6.35 p.m., I was fortunate enough to see a brilliant meteor descending a little north of Castor. My attention was drawn to it by the brilliant light it threw over the country. The head was a ball of dazzling white and the tail yellow, with red streaks. It disappeared before reaching the earth, and I heard no report or rushing sound whatever.

As the duration was only a few seconds the above are more impressions than observations. W. POLLARD.

Pirton, Herts, January 7.

CHEMICAL SOCIETY'S MEMORIAL LECTURES.

AT an extra meeting of the Chemical Society, held on December 13 last, this being the first anniversary of the death of Stas, a paper was read and discussed which had been prepared for the occasion by Prof. J. W. Mallet, F.R.S., of the University of Virginia, U.S.N.A.—himself a high authority on atomic weight determinations, and well known to chemists through his papers on the atomic weights of aluminium and gold, published by the Royal Society of London.

The lecture marks a new departure in the work of the society. Hitherto our learned societies have been in the habit of publishing more or less complete—it would probably be nearer the truth to say incomplete—obituary notices of their foreign members. The Chemical Society has come to the conclusion, however, that inasmuch as its foreign members are always men of great distinction who, as a rule, have lived a considerable number of years after accomplishing their life work, it will be to the advantage of its fellows and of chemists generally, if the obituary notices of foreign members take the form of critical monographs of the subjects with which they have principally dealt.

The anniversary of the death of the foreign member is obviously the most appropriate occasion for the delivery of such a lecture. During the past year the society has lost two of its foreign members: Hermann Kopp, noted as an historian, as well as on account of his very numerous exact determinations of atomic volumes and specific heats, and A. W. von Hofmann. The life and work of the first mentioned will form the subject of a lecture to be delivered on February 20 next, by Prof. Thorpe, the Treasurer of the Society, than whom no one is more qualified to undertake the task. Prof. Thorpe is not only a pupil of the deceased chemist, but has reverently followed in his footsteps—having very largely extended Kopp's observations on atomic volumes in an elaborate investigation, the importance of which was recognised by the Chemical Society in 1881 through the award to him of its first Longstaff medal.

Von Hofmann, although originally a foreign member, became an ordinary member of the Chemical Society on coming to England as professor at the school in Oxford Street, long since merged in what is now known as the Royal College of Science, London. Hofmann was never again regarded as a foreigner; he served the society both as foreign secretary and as president, filling one of the vice-chairs during the remainder of his life. It is felt that owing to the special nature of his relations to the society and to english chemistry, it will be necessary to deal with his case in an exceptional manner; it is therefore hoped that in May next Lord Playfair—who was so intimately connected in his early days with chemical science and with the society—in the first place will picture the state of affairs chemical at and prior to the time of Hofmann's arrival in England. Sir F. Abel, Hofmann's first pupil and assistant, will follow with an account of Hofmann at the Royal College of Chemistry, calling to his aid for this purpose the remaining friends and pupils of Hofmann. The coal-tar colour industry, which has now attained such important dimensions, it is well known, had its origin in the Oxford Street laboratory, and Dr. Perkin—its parent—has consented to sketch the history of its development. In this manner it is hoped to impart considerable "local colour" to the Hofmann memorial lecture, thereby distinguishing it from the notice which is being prepared by the German biographers.

Passing now to Prof. Mallet's lecture on Stas, which is of considerable length, as it will occupy fully sixty pages in the Society's Journal. The biographical portion is brief, as a number of such sketches have already been published. Stas was born at Louvain on August 21, 1813. He graduated as Doctor of Medicine. His taste for chemical research was evidenced in 1835, when, together with a friend, he investigated in an attic of his father's house the crystalline substance phloridzin which they had extracted from the root bark of the apple tree. He continued the study of this substance in Dumas' laboratory in Paris, and it is an interesting proof of the acumen of Berzelius that in his annual report on the progress of chemistry he referred to this first research made by Stas with praise, and a prediction of future eminence for the author.

The starting-point of the long train of research with which his name will ever be associated was the redetermination of the atomic mass of carbon which Dumas and he together undertook, in order to explain the fact, noticed by Liebig and others, that the sum of the carbon and hydrogen found in hydrocarbons by the combustion process, as calculated from the carbon dioxide and water, not unfrequently exceeded the quantity of material analyzed. As the result of this investigation, which was carried out with unprecedented care and the most elaborate precautions, the value hitherto accepted for carbon on the authority of Berzelius ($76 \cdot 432$ $O = 100$) was considerably reduced (to $75 \cdot 005$). In 1840 Stas was appointed Professor in the École Royale Militaire at Brussels; he held this post for more than a quarter of a century, until an affection of the bronchial tubes and larynx obliged him to give up lecturing. He then received an appointment in the Mint, but resigned this in 1872 on political grounds, and withdrew into private life. He appears to have been a man of great independence of character.

Apart from his atomic weight investigations Stas did much work of value in other departments. His method of separating alkaloids from organic messes—no other name is applicable—which has been of such service in subsequent toxicological inquiries, was devised in 1850, in the course of the inquiry into the celebrated Bocarmé nicotine poisoning case. He examined into the methods of hydrolysing fats for the purpose of a report on the chemical section of the London 1862 Exhibition. In connection with the preparation of international standards he took an active part, along with Devile, in the inquiry into the properties of the platinum metals. It is known also that he did important work for his Government in investigating alloys for use in the construction of artillery.

Prof. Mallet prefaces his account of Stas's special investigations by an historical survey of the fundamental ideas which have gradually led up to the question, What is the mass of an atom of a particular element? Even in and beyond the days of Cavendish and Priestley the fact that atmospheric air was found of constant or nearly constant composition was long a stumbling-block in the way of clear distinction between a homogeneous compound and a uniform mixture. To the labours of Van Helmont, Boyle, and Boerhave much credit is due for the gradual advance towards the doctrine of the conservation of matter. The discoveries of Black and Cavendish brought it further into view, and it assumed its due importance and began to receive universal recognition with the constant appeal to the balance which Lavoisier made and taught others to make. Next came a comparison of the quantities of different substances, at first chiefly the then known acids and bases, which would enter into combination with each other. Proust, in the course of his controversy with Berthollet as to the fixedness of combining proportions, had observed that in certain cases it was true that in different compounds, consisting of the same constituents, for a fixed quantity of one constituent, the different quantities of another constituent bear to each other a simple multiple or sub-multiple relation. To Dalton, however, belongs the honour of announcing the principle as a general one, and of basing upon it a true chemical atomic theory of the nature of matter. Berzelius,

in the early years of the present century, with apparatus in many respects inferior to that of the present day, and with scarcely any aid from chemical manufacturers in preparing pure materials and reagents, but with unsurpassed manipulative skill and the most honest criticism of his own work, produced the first fairly trustworthy list of numbers representing the proportions by weight in which the elements combine. Berzelius began work in this direction in 1807, his attention having been attracted by Richter's investigations; but soon afterwards he became acquainted with Dalton's new atomic theory of the nature of combination, and appears to have been impressed with its great importance, and at the same time with the need of more exact experimental data for its support and development. The wonderful accuracy of Berzelius's work generally is illustrated, as Prof. Mallet points out, by the fact that his number for oxygen, 16·021, becomes 15·894, almost exactly agreeing with the latest determinations of the present day, if the weighings of Dulong and Berzelius's three experiments on the synthesis of water be corrected for the buoyancy of the air. Since Berzelius many other chemists have worked in the same field, but his most worthy successor in such labours has undoubtedly been Stas. With greatly better resources in the way both of apparatus and material, with equal earnestness in seeking for the truth, with equal intelligence and skill he took up the task which became that of the largest part of his scientific life, and for a more limited list of elements than Berzelius had investigated, produced results of a degree of accuracy which it is high praise to say would have delighted no one more than Berzelius himself. He aimed at the determination with greater precision than any one before him had attained of the atomic weights of some ten or twelve of the elements. But by so determining these constants he endeavoured also to settle several general questions of fundamental importance in regard to matter as studied by the chemist.

Thus it has generally been assumed as true beyond dispute since the early part of the present century, that the mass of an atom of a given element is a constant quantity. This has, however, occasionally been doubted, and Stas himself considered the question as one requiring examination. His researches, however, lend no support to it. On this point Prof. Mallet expresses himself strongly in favour of the orthodox view.

Assuming that the atomic weights are immutable values, the question arises, Are they commensurable? This is the much-discussed hypothesis of Prout, the origin and development of which is very fully discussed by Prof. Mallet. A widespread feeling at one time undoubtedly existed among chemists that Prout's hypothesis, that the atomic weights of the other elements are integer multiples of that of hydrogen, if not true in its original form would ultimately prove to be so at least in a modified form. That Stas began his work under the influence of this feeling is clear from his own words:—

"Je le dis hautement lorsque j'ai entrepris mes recherches, j'avais une confiance presque absolue dans l'exactitude du principe de Prout."

But his experimental results clearly contradicted the hypothesis, and he satisfied himself that the atomic weights of the elements which he determined with such precision could not with truth be represented by integer multiples of the atomic weight of hydrogen, or the half or the fourth of this unit. In his own words:—

"Aussi longtemps que, pour l'établissement des lois qui régissent la matière on veut s'en tenir l'expérience, on doit considérer la loi de Prout comme une pure illusion. La simplicité de rapport de poids que présuppose l'hypothèse de Prout entre les masses qui interviennent dans l'action chimique, ne s'observe donc point dans l'expérience; elle n'existe point dans la réalité des choses."

The great majority of chemists—Prof. Mallet remarks—at the present day, are probably agreed in believing that the hypothesis of Prout has been shown by Stas to be untenable. But the fact that so many well determined atomic weights, referred to hydrogen as unity present numbers *nearly approaching integers*, is very striking and calls for further investigation. Stas himself is quoted as admitting this much. Prof. Dewar, in the course of the discussion after the paper was read, drew special attention to this question and gave several most striking instances of the nearer approach to whole numbers which resulted from a recalculation of the accepted values, using the lower value for oxygen (15·87) which so many recent researches tend to support, although on the other hand, of course, some of the values now near to whole numbers are considerably thrown out. Evidently there is ample opportunity for further experimental investigation of this all-important problem, and it is impossible—notwithstanding the extraordinary degree of accuracy attained by Stas—to formulate any final conclusion. The supreme interest attaching to the problem was clearly recognised by Stas himself, as the following words show:—

"Au point de vue de la philosophie naturelle, la portée de l'idée de Prout est immense. Les éléments des corps composés que nous considérons comme des corps simples en égard à leur immutabilité absolue pour nous, ne seraient eux-mêmes que des corps composés. Ces éléments, dont la découverte fait la gloire de Lavoisier et a immortalisé son nom peuvent être considérés ainsi comme dérivant de la condensation d'une matière unique: nous sommes naturellement conduits à l'unité de la matière, quoi qu'en realité nous constations sa pluralité, sa multiplicité."

This quotation is almost alone sufficient to show that Stas was a philosophical chemist of the highest order, and not a mere mechanical worker, as has sometimes been supposed; his unwearied attention to minutest details has undoubtedly served to completely overshadow the philosophical motives and aspirations by which he was guided.

Stas also endeavoured to obtain evidence with regard to the possible dissociation of the elements at high temperatures and to this end purified his materials with every imaginable precaution. The skill with which he carried out his operations is attested by the statement made by Mr. Crookes, the chairman at the reading of Prof. Mallet's paper, that he had seen in Stas's laboratory a large mass of potassium chloride, which Stas had been years in preparing, and in which he had failed to find a trace of sodium even spectroscopically—such an achievement appears almost inconceivable to the chemist. Stas, in fact, in the course of his work investigated the methods of analysis to be used with a degree of rigour, and discovered and applied refinements upon older methods of experiment with a degree of patience and skill, such as had never before been used in chemical investigation. Only those who are thoroughly conversant with such work can fully appreciate his labours; they probably will agree that owing to the multitude and diversity of the precautions to be taken, his work is the most difficult hitherto attempted, and that he stands unsurpassed among all who have undertaken the execution of exact physical measurements.

A lengthy section of Prof. Mallet's paper is devoted to the consideration of the objects to be aimed at and the methods to be pursued in future work. He advocates the repetition by competent hands of some one at least of Stas's fundamental results, calling attention to Stas's own emphatic expression of the wish that this should be done. It is also most important that no distinction should be made between rare and common elements, and that the atomic weights of all should be determined with the least possible delay and the highest attainable degree of accuracy. Certain of the elements particularly call

for a more searching and exact investigation of their atomic masses, *e.g.* elements such as tellurium, which occupies a position in the periodic system not in harmony with its atomic mass, and cobalt, which plainly occupies the intermediate position between iron and nickel, and therefore should be intermediate in atomic mass.

In a number of cases the accepted value is based on the investigation of but a single interchange, the value for iron, for instance, being practically based on the results obtained on converting the metal into ferric oxide, and *vice-versâ*; and the relation of hydrogen to oxygen having been established by the reduction of cupric oxide. It is desirable that in such cases other and independent methods should be resorted to, *e.g.* that oxides of a number of metals other than copper should be reduced, with the object of detecting possible constant errors.

It is eminently desirable that an attempt be made to directly determine the ratio of hydrogen to each of the halogens without in any way bringing in the atomic mass of oxygen. Prof. Mallet suggests various methods deserving of study. Also it is very important that the metals of the yttrium and didymium groups should be further investigated. Prof. Mallet rightly terms the yttrium group the opprobrium of inorganic chemistry.

Nearly all that has been written hitherto in regard to the periodic relationship among the elements has involved the use of roughly approximate values only; but it is time that the foundation be laid for a more minute and critical study of the periodic system of classification. Anomalies in the classification as we now find it in our books, glimpses of more detailed relations than as yet clearly appear, tantalizing suggestiveness in so much of what is already before us, call for more precise determinations of the numbers we would discuss before we allow premature discussion to drift into mere fanciful speculation.

In regard to the methods which it is desirable shall be pursued in the determination of atomic masses, Prof. Mallet has much to say. He discusses the selection of processes, the purity of materials, the very numerous directions in which vigilance must be exercised in order to avoid extraneous or accidental causes of error, the quantities of material to be used, the practical precautions to be observed so as to secure accuracy of manipulation and in weighing and measuring, the mode of stating and calculating results, finally calling attention to the advantage to be derived from the application of greater working force and ampler means than can be commanded by private individuals to the determination of atomic masses; with reference to this last point, during the discussion on the paper, the opinion was freely expressed that it was undesirable that such work should be carried out in organized public or semi-public laboratories. The question is, no doubt, a difficult one to settle—such work demands a special temperament combined with genius of a high order and an infinite capacity for taking pains, qualities which must rarely occur united in a single individual. Moreover, in order that the value of a result may be appraised, it is essential to overlook every detail involved in the determination. Given the man, however, there can be no longer a doubt that every possible assistance he may require should be afforded him. It is marvellous that men like Berzelius and Stas, working all but alone and unaided, should have achieved results of such magnitude and universal importance—the moral effect of their example is certainly not less important than are the actual results of their labour.

The last section of Prof. Mallet's paper is devoted to the discussion of the form in which it is desirable finally to state the results. He here advocates the uniform substitution of the expression "atomic mass" for "atomic weight," on the ground that precision in language conduces to precision in thought—an aphorism far too commonly disregarded by chemists. We have now clear conceptions of atoms having constant mass for the same element, of determinable difference of mass in the case of different elements, the several masses and numbers of which regulate the composition of all known substances and the products resulting from interaction among them. The atomic theory has advanced far beyond the condition of a mere working hypothesis on which chemists long stood with more or less uncertain feet; but even if this were not so, considering it, to use a common metaphor, only as a scaffold, there is no good reason, so long as we stand on it and work from it, that we should be careless about tying our scaffold-poles and nailing our planks.

Lastly, Prof. Mallet urges that all atomic masses shall be expressed in terms of the mass of the hydrogen atom taken as unity, objecting strongly to the change to $O = 16$ which several writers have recently advocated, the most objectionable argument put forward in favour of such change being, he thinks, that the numbers we use are expressive of *ratios* only—that any figures are allowable which correctly express combining ratios, and that there are no reasons for using one set of figures rather than another save mere arithmetical convenience. This involves a grave error, as in adopting as unity the mass of a single atom of any particular element, preferably that one of which the mass is the smallest, we have reason to believe that we express the mass of all the others in terms of this as a really existent, definite, and constant quantity of matter. It is, indeed, difficult to understand when the scientific necessity in so many cases of taking hydrogen as the unit is realized, how the change to $O = 16$ can be advocated except on the simple utilitarian plea that it is to the analyst's convenience.

Prof. Mallet's monograph is undoubtedly a most admirable exposition of the philosophical lessons to be learnt from the contemplation of Stas's labours.

EXTINCT MONSTERS.[1]

THE volume with this title treats of large animals. It is clearly and simply written, without any pretence at being scientific, and is an excellent book for boys and unlearned people who are curious to be informed upon the subject of fossil animals. It would have escaped criticism altogether but for emphatic words of praise in the preface, and one or two passages in which the author, with second-hand information, speaks authoritatively of predecessors who restored extinct types of life with the slender materials which were available forty years ago. The attraction of the volume and its novelty is a series of restorations of saurians and mammals drawn chiefly by Mr. Smit. These for the most part are based upon the restorations of skeletons made by Prof. Marsh, whose discoveries have inspired Mr. Smit's pencil as much as they have influenced the author's pen. There is not much anatomy beneath the skins of the "Monsters," and they have an aspect as though cotton-wool had taken the place of muscle, or as though the drawings were models for the "Lowther Arcade." This, however, is of less importance than the answer given to the question, Are they reasonably faithful to nature? It does not seem to me that they can claim this merit; they are only reasonably faithful to Marsh. Prof. Marsh draws an animal so as to give one type the maximum height to which the bones can be hoisted; while another is given the maximum length to which the remains can be extended. My own studies would not have led me to reconstruct one of the extinct reptiles upon the lines which are adopted in

[1] "Extinct Monsters." A popular account of some of the larger forms of ancient animal life. By Rev. H. N. Hutchinson, B.A., F.G.S., with illustrations by J. Smit and others. (London: Chapman and Hall, Ld., 1892.)

these restorations. As an example of how a restoration should not be made, we may instance the figure of *Stegosaurus ungulatus* (p. 104), in which the management of the limbs is out of harmony with the evidences of the muscular structure of the tail, and the supra-vertebral crest. The restoration of the Scelidosaurus from the Lias of England is unsatisfactory. There is no better ground for giving a kangaroo-like position to that animal than there would be for drawing Teleosaurus in the same position. The mobility of the neck as drawn is astonishing.

The restorations of mammals are happier. The subjects diverge less from existing types. And probably the most successful in the volume is the spirited restoration of *Sivatherium giganteum* from the Sivalic Hills, though the Glyptodon and Irish Deer are meritorious.

In the text the author is generally content with telling the story of the history of science; but he sometimes strays into less safe matter. Thus an account is given of the eye of the Ichthyosaurus. And it is urged that the bony plates exercised a pressure on the eyeball, so as to make the eye more convex, and improve the definition of near objects. The study of sclerotic defences does not support this interpretation; and in at least one generic division of the Ichthyosauria the sclerotic plates do not overlap at all, but join each other by their lateral sutural margins.

The four-horned extinct Mammal *Sivatherium giganteum*. The animal on the left is Heladotherium.

It is perhaps unfortunate that the author gives currency to nomenclature and classification of the terrestrial types of saurians which may not always prevail. If the genera with a bird-like type of pelvis are terrestrial representatives of birds, and the genera with a reptilian type of pelvis are terrestrial wingless representatives of Pterodactyls, then it may not be an advantage to have the Dinosaurs treated as a homogeneous group, or the divisions adopted by Prof. Marsh, or in the British Museum (Natural History), handed on to the unlearned as representing the best available classification. On page 75, the author introduces a restored skeleton of Megalosaurus, which is attributed to Prof. Marsh. The skeleton certainly is not referable to Megalosaurus, which never has the pubic bones or the ilium constructed as in the figure. The restoration has been previously used in Nicholson and Lydekker's "Palæontology," and in Dr. Woodward's "Handbook to the Geological Department of the British Museum," but we do not remember any published authorization for the use of Prof. Marsh's name as authority for confounding Megalosaurus with the allied American type.

Another example of the same kind of interpretation occurs in dealing with Stegosaurus. It is said to have been proved that bones to which the name Omosaurus has been applied really belong to Stegosaurus, and that an unnecessary name has been disposed of. The ground on which this determination is made, not being stated need not concern us now; but it is undesirable that a popular work, whose main merit is that it does not pretend to teach the facts of science, should appear to enunciate judgments on scientific problems. Having described the immense enlargement of the spinal cord in the sacral region of Stegosaurus, the author remarks:—"So this anomalous monster had two sets of brains—one in its skull, and the other in the region of its haunches!—and the latter in directing the movements of the huge hind limbs and tail did a large part of the work." Remarks of this character are sure to be misunderstood, are out of place and incorrect.

The author has read much, and shown an excellent capacity for quotation, but has not always succeeded in using the newest results. He has conscientiously endeavoured to tell the story which is contained in his quotations, but beyond this he does not pretend, except

in the occasional use of supposed scientific principles as a means of accounting for facts of animal structure. He has dealt with a subject of great difficulty with commendable clearness, and will interest readers who would be unable to follow a more technical exposition of extinct types of life. H. G. S.

ENERGY AND VISION.

THE interesting researches of Prof. S. P. Langley on energy and vision have recently been published in the Memoirs of the American National Academy of Sciences. From this we gather that he was led to investigate the question by the fact that it was not generally recognized how totally different effects may be produced by the same amount of energy in different parts of the spectrum. Two series of experiments were necessary, the first to determine the amount of energy in each ray, the second to observe the corresponding visual effect. The energy was determined as heat by the use of the bolometer, the heat dispersed by a prism being very nearly proportionate to the energy.

In the second series of experiments a beam of sunlight from a siderostat passes through a small hole in a darkened room and falls on a slit with a standard width of 0·1 mm. It is then received on a collimating lens of 11·9 centimetres aperture and 755 centimetres focal length, after which it passes through a prism of about 60° refracting angle. The spectrum thus formed is reflected and brought to a focus on a second slit of one millimetre aperture by a concave mirror, any particular colour being adjusted on the slit by a rotation of the prism. This second slit is screened from all possible stray light by a dark curtain, and is used as a source of illumination for a series of numbers from a table of logarithms, which is attached to a sliding screen. The greatest distance from the slit at which the figures could be distinctly read was then determined, and the law of inverse squares applied. For the brighter colours of the spectrum, the light entering the first slit was reduced by an adjustable photometer wheel.

Actinometric measures were made during the progress of the photometric observations, and showed a solar radiation of 1·5 calories per square centimetre per minute; this naturally being an essential unit.

The energy necessary to give the bare impression of luminosity in different parts of the spectrum, expressed in terms of horse-power, was found to be roughly as follows, the *minimum visibile* being defined as the feeblest light which is observed to vanish and reappear when silently occulted and restored without the knowledge of the observer:—

		Horse-power.
Violet (λ 400)	...	0·000000 000000 00018000
Green (λ 550)	...	0·000000 000000 00000075
Scarlet (λ 650)	...	0·000000 000000 00017000
Crimson (λ 750)	...	0·000000 000000 34000000

These values were derived from observations made by a single observer, Mr. F. W. Very, and are, of course, subject to a large percentage of error.

The general results of the investigation may be best summarized in Prof. Langley's own words:—

"The time required for the distinct perception of an excessively faint light is about one-half second. A relatively very long time is, however, needed for the recovery of sensitiveness after exposure to a bright light, and the time demanded for this restoration of complete visual power appears to be greatest when the light to be perceived is of a violet colour. The amount of energy required to make us *see* varies enormously according to the colour of the light in question. It varies considerably between eyes which may ordinarily be called normal ones, but an average from those of four persons gives the following proportionate result for seven points in the normal spectrum, whose wave-lengths correspond approximately with those of the ordinary colour divisions, where unity is the amount of energy required to make us see light in the extreme red of the spectrum near A, and where the six preceding wave-lengths given correspond approximately to the six colours, violet, blue, green, yellow, orange, red.

Colour	Violet	Blue	Green	Yellow	Orange	Red	Crimson
Wave length	400	470	530	580	600	650	750
Luminosity	1600	62,000	100,000	28,000	14 000	1200	1

It appears from this that the same amount of energy may produce at least 100,000 times the visual effect in one colour of the spectrum that it does in another.

If now it be inquired what the actual value of unity is in ordinary measure, we are able to give this also with a fair approximation, and to say that the *vis-viva* of the waves whose length is 7500 (tenth metres) being arrested by the ordinary retina, represents work done in giving rise to the sensation of the deepest red light of about 0·001 of an erg in one-half second.

NOTES.

THE Prince of Wales has consented to become Chairman of the Committee for the memorial of the late Sir Richard Owen, and to preside at a meeting to further the object, which will be held in the rooms of the Royal Society, Burlington House, on Saturday, the 21st inst., at half-past eleven o'clock. Admission will be by tickets, which may be obtained from Mr. Percy Sladen, Linnean Society, Burlington House, W. (who is acting as secretary to the Committee), or from Mr. H. Rix, assistant secretary of the Royal Society.

THE annual general meeting of the Royal Meteorological Society will be held at 25, Gre at George-street, Westminster, on Wednesday, the 18th instant, at 7.15 p.m., when the Report of the Council will be read, the election of officers and council for the ensuing year will take place, and the President (Dr. C. Theodore Williams) will deliver an address on "The High Altitudes of Colorado and their Climates," which will be illustrated by a number of lantern slides. This meeting will be preceded by an ordinary meeting, which will begin at 7 p.m.

THE general meeting of the Association for the Improvement of Geometrical Teaching is to be held at University College, Gower Street, W.C., on Saturday, January 14, the Rev. C. Taylor in the chair. At the morning sitting (11 a.m.) the report of the Council will be read, the new officers will be elected, and several candidates will be proposed for election as members of the Association. After the conclusion of the formal business Mis. Bryant will give "A Model Lesson on Geometry, as a Basis for Discussion." After an adjournment for luncheon at 1 p.m. members will re-assemble (2 p.m.) to hear papers by Mr. G. Heppel on "The Use of History in Teaching Mathematics," and Mr. F. E. Marshall on "The Teaching of Elementary Arithmetic." Members who wish to have any special matter brought forward at the general meeting, but who are unable to attend, are requested to communicate with one of the Honorary Secretaries. All interested in the objects of the Association are invited to attend.

DR. LUDWIG BECKER has been appointed to the chair of astronomy at the University of Glasgow.

THE Comet Medal of the Astronomical Society of the Pacific Coast has been awarded to Mr. Edwin Holmes, of London, for his discovery of a new comet on November 6.

ON Tuesday next (January 17) Prof. Victor Horsley, F.R.S., will begin a course of ten lectures, at the Royal Institution, on "The Functions of the Cerebellum and the Elementary Prin-

ciples of Psycho-Physiology." The Friday evening meeting will begin on January 20, when Prof. Dewar, F.R.S., will give a discourse on "Liqnid Atmospheric Air."

THE severe frost which set in just before Christmas was succeeded by a rapid rise of temperature in Scotland on Friday, but in England the thermometer did not rise much above the freezing point until about twenty-four hours later. On the 5th and 6th instant the thermometer fell below 10° in many parts of Great Britain, and snow was falling in Scotland, which afterwards spread to many parts of England. The absolute shade minima recorded were—2° at Braemar, and 2° at Fort Augustus, in the north of Scotland. The distribution of pressure was unusually high over Scandinavia and northern Europe (inadvertently referred to in our issue last week as over these islands) having reached about 31·3 inches in Central Russia on the 4th, while areas of low pressure lay over the Gulf of Genoa and the south-west of Ireland. The latter depression gradually extended eastwards, causing strong easterly gales on the Irish coasts, while the anticyclone over Europe gradually gave way, the barometer at Haparanda on Monday being 1·5 inch lower than a few days previously. By Sunday all stations reported temperatures above the freezing point, while in the south-west of Ireland the maxima reached 47° and in the south of France even 63°. These changes were accompanied by rain in most parts of the country, which added materially to the rapidity of the thaw. Bright aurora was seen on Monday night in Scotland and Ireland. On Tuesday an anticyclone from the north-westward was spreading over our islands, with finer weather and lower temperatures generally, frost occurring in the north of Scotland and the central parts of England. The *Weekly Weather Report* of the 7th instant showed that the temperature in the eastern and midland parts of England was 12° to 13° below the average for the week; at several of the inland stations in England the daily maxima were below 32° through the whole period.

AN enlightened Bengali, Babu Govind Chandra Laha, has contributed fifteen thousand rupees towards the expenses of the proposed snake laboratory at Calcutta. We may expect, therefore, that the institution will soon be in full working order. According to the *Pioneer Mail*, two main lines of research will be followed in the laboratory. So-called cures for snake-bites will be tested under strictly scientific conditions, and the properties of the snake poison as such will be investigated. The laboratory will be the only institution of its kind in the world, and the Committee of the Calcutta Zoological Gardens, who have taken the matter in hand, expect that it will be largely resorted to by the scientific inquirers who visit India during cold weather. In accordance with the practice of scientific laboratories in Europe, a charge will be made for the use of the tables and instruments at a rate sufficient to cover working expenses. Work done on behalf of the Government will also be charged for according to a regular scale.

THE members and friends of the Society for the Study of Inebriety met on Tuesday to congratulate Dr. Severin Wielobycki on having completed one hundred years of life.

PROF. BAIN contributes to the new number of *Mind* an interesting sketch of the career of the late Prof. G. C. Robertson, with whose name *Mind* will always be intimately associated. Prof. Bain includes in his article the admirable notice of Robertson written by Mr. Leslie Stephen for the *Spectator*.

WE are glad to note the publication of a fifth edition, revised and augmented, of the Official Guide to the North Gallery at the Royal Gardens, Kew. It includes a short and interesting biographical notice of Miss North. A map is given to convey some idea of the extent to which her collection illustrates the vegetation of the temperate and tropical regions of the world.

A NEW edition of the list of members of the Institution of Civil Engineers, corrected to the 2nd inst., the seventy-fifth anniversary of its establishment, shows that the aggregate number of all classes is 6341, an increase during the past year at the rate of $3\frac{1}{2}$ per cent.

A PSYCHOLOGICAL laboratory has been established at Yale College, where Prof. Ladd has for some years been lecturing on physiological psychology. *Science* gives an interesting account of the new institution, which has been placed under the charge of Dr. E. W. Scripture, a pupil of Wundt. The laboratory consists of fifteen rooms, three of which, including an "isolated" room, are given over entirely to research. The isolated room is a small room built inside of another room; four springs of rubber and felt are the only points in which it comes in contact with the outer walls. The space between the walls is filled with sawdust as in an ice-box. The room is thus proof against sound and light, and, according to *Science*, affords an opportunity of making more accurate experiments on the mental condition than any yet attempted.

STUDENTS of ethnography will be interested to hear that Dr. N. B. Emerson, of Honolulu, is preparing a full account of the Polynesian canoe. In a communication printed in the new number of the Journal of the Polynesian Society he points out that the various migrations of the ancient Polynesians and their progenitors, from whatever source derived, must have been accomplished in canoes or other craft, and that the *waa*, the *pahi*, &c., of to-day, however modified they may be under the operation of modern arts and appliances, are the lineal descendants of the sea-going craft in which the early ancestors of the Polynesians made their voyages generations ago. He holds, therefore, that a comparative study of the canoes cannot fail to shed light on the problems of Polynesian migrations and relationships.

AN interesting little paper on the destruction of wild birds' eggs, and egg-collecting, is contributed to the new number of the *Annals of Scottish Natural History*, by Col. W. H. M. Duthie. Collectors who require to be specially dealt with he groups in three classes—the aimless, the greedy, and the mercenary. In contrast with these is "the true collector," whom Col. Duthie defines as "a naturalist, acquainting himself with birds, their habits, flight, migration, language, and breeding haunts; his egg-collecting being only one of the means of acquiring this knowledge." The true collector should collect for himself, and should never receive an egg into his cabinet unless authenticated by an individual in whom he can implicitly trust. If all collectors were of this type, egg-dealers would cease to exist, and with them would disappear the tribe of hangers-on whom they maintain.

A GOOD study of the form of eggs has been recently made by Dr. Nicolsky of St. Petersburg. He constructs an abstract formula, by which different eggs can be compared without regard to absolute dimensions. Calling the longer axis 1000, he obtains a figure representing the ratio of the longest transverse axis to it, and another, that of the distance of the obtuse end from the "centre," or point where the longer axis cuts the plane of the equator; then forms a fraction with these two figures, and takes it as the formula of the egg. Various explanations have been offered for the different forms of eggs. Dr. Nicolsky traces all to gravity. He considers that every egg not yet coated with a solid shell departs from the spherical form and elongates, simply because of pressure on it by the walls of the ovary. In birds which keep a vertical position when at rest (such as the falcon and owl) the soft egg becomes short through the bird's weight acting against the ovarian pressure. In birds which, like the grebe, are nearly always swimming, the egg lengthens, because the body weight acts in the same direction as the ovarian compression. Lastly, eggs become

pyriform (more pointed at one end than the other) in birds which, like the guillemot, often change their position, sometimes swimming and diving, sometimes perching on rocks, &c. An examination of all the eggs in the zoological collection of the St. Petersburg University fully bore out these views. Dr. Nicolsky thinks it would be useful to test the theory by experimentation, birds being kept in a vertical or horizontal position at the laying time.

FOR twelve years (1878 to 1890) M. P. Plantamour made careful observations of the displacements shown by two spirit levels (one north-south, the other east-west), in the cellar of his house at Sécheron. The instruments were transferred to the Geneva Observatory, and the work resumed by M. Pidoux in April 1891 (after six months' interruption). M. Plantamour found that the mean air temperature had a preponderating influence in the oscillations observed, while some other factors of obscure nature were involved. The first year's data at Geneva (*Arch. de Sci.*) reveal an annual oscillation of the ground of the Observatory about an axis directed north-east and south-west, such that the south-east part sinks in summer and rises in winter. The east side went down till July 16, then rose gradually till the end of December (29), thereafter sinking again. The extremes were $-4''\cdot73$ and $+4''\cdot85$ (an amplitude of $9''\cdot58$). The variations of the south side were similar, but the amplitude somewhat greater. The north-south level showed some quite abnormal variations in the autumn of 1891, to which, however, the author does not attach great importance.

AN interesting contribution to our knowledge of the adaptation of structure to function in the human body is afforded in an investigation by Signor Minervini (of the Naples Society of Naturalists) of the blood-vessels of the skin in different parts. Portions of skin were prepared so as to show the exact structure of the chief arteries in them. The results are as follows:—(1) The artery-walls of the skin in men are generally thicker than those of other organs. (2) This greater thickness is due generally, and during most of life, to thickening of the middle layer; but in childhood the outer, and in advanced years the innermost, layer is most developed. (3) The artery-walls in the hollow of the hand, the finger-tips, and the sole, are, other things equal, thicker than those in the back of the hand, the forehead, the arm, &c. This greater thickness is due chiefly to a greater development of the middle layer, and in all ages of life. The arteries in the hollow of the hand in the case of occupations involving hard manual labour show a greater increase of thickness than in the case of those with little or no such work. In these cases all three layers of the artery are thickened, but the middle layer most. (4) In women all the chief arteries of the hollow of the hand and of the back of the hand are somewhat less thick than in men. The difference is not great, but occurs at all ages.

IN a paper on the Santa Isabel Nitrate Works, Toca Chile, read lately before the Scottish Institution of Engineers and Shipbuilders, and now printed in the Institution's Transactions, Mr. G. M. Hunter has something to say regarding the origin of "caliche," as nitrate of soda is called in its native state. Some contend that "caliche" is a marine deposit, others that it is an animal deposit, while others say it is a vegetable deposit. Mr. Hunter holds the first of these views. The coast of Chile has several times been disturbed and upheaved by volcanic agency, and he suggests that a large tract of sea was enclosed and heaved up to the present height of the nitrate region, and there formed an inland sea, which, after a lapse of time under a tropical sun, evaporated, leaving the salts to percolate and form the beds of nitrate. From the formation of the ground, showing depressions and ravines leading to the sea, it is evident that immense volumes of water at some remote period have passed through them. In proof of this, Mr Hunter points out that no "caliche" is ever found in such places, the accepted opinion being that there has been a "wash out," as it is called. During a later period than that of the formation of the "caliche" great floods passed over the plains, as is shown by the deep tracks of rivers, and the smooth washed appearance of the surface. Such periodical floods are common in tropical, rainless regions, and would not call for special remark, but from the fact that wherever these river tracks or washed surface appear no "caliche" can be found. This is so well known that even the workmen never attempt to search for it in such places. The only surface indication for the presence of "caliche" is rising ground covered with small black stones. The "caliche" in its native state is white, very compact and amorphous, not unlike rock salt, but when rich in iodine it assumes various colours, according to the composition and quality of the iodine it contains. For example, at times it contains masses of bright yellow, red, or blue, and again wholly composed of a dull black colour, in which state it requires an expert to distinguish it from *costra* or rock.

MR. E. LOMMEL claims to have found a simple explanation of the Hall effect. A simple train of reasoning shows, he says, that the equipotential lines perpendicular to the lines of flow in a plate are also the lines of force due to the current. If iron filings are strewn upon the plate they will arrange themselves along the equipotential lines if the current be strong enough. On bringing the plate into a magnetic field these lines of force change their position. Hence the lines of flow, necessarily orthogonal to the lines of force, will also change in form and position.

ACCORDING to Dr. J. Böhm, the statement that *Phytophthora infestans*, the fungus which causes the potatoe diseases, hibernates in the tubers, is incorrect, nothing whatever being known about its mode of hibernation. He further states that the infection of the potatoes never takes place in the soil through the uninjured skin, but is always brought about through injury to the tubers by insects or snails. In potatoe-heaps sound tubers can never be infected by their diseased neighbours. An infected potatoe either does not germinate at all or produces a healthy plant.

IN examining milk which is suspected to contain the tubercle bacillus it is usual to subject a sample of the milk to the action of a centrifugal machine after separating the fat. One method of working is described by Ilkewitsch (*Münchener med. Wochenschr.* 1892). The casein in 20 c.c. of milk is coagulated with citric acid, and, after filtering, the residue is dissolved in a solution of sodium phosphate. The butter-fat is separated by shaking with 6 c.c. of an aqueous ether solution, and acetic acid is then added until the liquid is on the point of coagulating. It is then placed in a copper tube tapering at the bottom, and this tube is inserted in the centrifugal machine and turned at the rate of 3600 revolutions per minute for fifteen minutes. The bacilli collect at the narrow end of the tube together with other sediment and dirt. The liquid is poured off, and the sediment examined microscopically. Thörner (*Chem. Ztg.* 1892, pp. 791–2) gives another method, which is as follows:—20 c.c. of the suspected milk are mixed with 1 c.c. of 50 per cent. potash solution, and heated in a bath of boiling water until the fat is saponified, when the solution turns yellowish brown. By this treatment the casein and albumen become soluble in acid. Twenty cubic centimetres of acetic acid are added, the solution shaken, heated on water-bath for three minutes, transferred to a strong glass tube, and turned in the centrifugal machine for ten minutes. The liquid is poured off, and the sediment is washed by shaking with 30 c.c. hot water, and again turned in the centrifugal machine. The water is poured off, and the sediment placed upon cover-glasses, which are treated in the ordinary way,

staining with hot Neelsen's solution, decolourizing in 25 p.c. sulphuric acid, and finally staining in methylene blue; instead of washing the cover-glasses in sulphuric acid Thörner simply uses a solution of methylene blue containing sulphuric acid.

A METHOD of producing an intense monochromatic light is described by Dr. Du Bois (*Zeitschr. für Instr.* p. 165). It differs from the usual processes in the form in which the sodium is introduced into the flame. A mixture of sodium bromide and bicarbonate is made cohesive by adraganth and moulded into sticks 4 mm. in diameter and 12 to 15 cm. long. These are kept in the flame of a Linnemann burner by means of a rack and pinion motion. Their conductivity being very low, they are only vaporized at the extreme end. The latter must be covered to avoid a continuous spectrum. At the greatest intensity, two or three centimetres of the substance are consumed per minute. The spectrum exhibits, besides the enormously preponderating D lines, a air of lines in the green, and a fainter pair in the red.

FROM the ages of persons who have died in France during the last 32 years, M. Turquan computes the average life there to have been about 38 years for women, 36 for men, and 37 years for both sexes together (*Rev. Sci.*). But this is now exceeded, and the average is over 40 years; a result, partly, of more attention to hygiene, partly of a diminished birth-rate. From a map showing the distribution of the average life, one finds the average very low in Finistère and Brittany (28 years 11 months in the former) in the Nord, the Pyrénées Orientales, &c., and especially in Corsica (28 years 1 month). In Finistère and Corsica one finds least hygiene and most children, but not the highest mortality of children. In some parts of Normandy, with a high infantile mortality, the mean life is yet very long. Thus it is about 48 years in Eure, 47 in Orne and Calvados, &c. The difference between the average life of men and women rises to 4 years (excess in case of women) in the north-west, and diminishes as you come towards the Mediterranean; and in Basses Alpes and Gard (in the south-east) man lives longer than woman by about a year and a half. In Normandy and Brittany there are most widows, and woman appears to have a greater vitality.

IT is now many years since electric currents were proved to exist in plants. In the study of these currents, an important step in advance was taken when Prof. Burdon Sanderson proved their existence in *uninjured* parts of living plants (it was usual before to apply electrodes, often polarizable, to cut parts). As to their cause, certain experiments made by Kunkel, some time ago, led him to think it was in the purely mechanical process of water-motion, set up on application of the moist electrode. The subject has been recently investigated by Herr Haake, who pronounces against this view. He used Du Bois Reymond's clay electrodes, with some woollen fibres projecting at the ends, and he enclosed the leaves in a tube in which they were guarded from air-draughts and kept moist. Arrangements were also made for various operations, such as varying transpiration, admitting hydrogen, removing oxygen, &c. (for details see *Flora*, p. 455, of this year). Herr Haake's results are briefly these:—1. It is unquestionable that changes of matter of various kinds are concerned in the production of the electric currents, especially oxygen respiration, and carbonic-acid assimilation. 2. Water-movements may possibly share in their production, but certainly their share is but a small one.

THE *Izvestia* of the East Siberian Geographical Society (vol. xxiii., 3) contains an account of M. Obrutcheffs' further researches in the Olekma and Vitim highlands. In the north-eastern, formerly quite unknown part of this region, the author found a further continuation of the "Patom plateau"—that is, a swelling from 3500 to 4000 feet high, devoid of tree vegetation, with ridges and mountains rising over it to heights of from 5000 to 5600 feet. They consist of granite and crystalline schists, probably of Laurentian age, covered with younger, probably Huronian, gneisses and schists. The other parts of the highlands consist of Cambrian and Lower Silurian deposits, while Upper Silurian limestones and Devonian Red sandstones are only met with in the valley of the Lena. We thus have a further confirmation of the hypothesis, according to which the great plateau of north-eastern Asia is a remnant of an old continent which has not been submerged since the Devonian epoch. Further traces of mighty glaciation have been found in the south-east part of the region. As to the gold-bearing deposits, they are pre-glacial in the south, and post-glacial or recent in the north. The high terraces in the valleys are indicative of a considerable post-pliocene accumulation of alluvial deposits, and of a subsequent denudation on a great scale.

MESSRS. MACMILLAN AND CO. announce that a new edition of Sir Archibald Geikie's "Text-book of Geology" is in the press, and will appear shortly.

THE third and fourth volumes (completing the work) of Mr. H. C. Burdett's "Hospitals and Asylums of the World" will be published by Messrs. J. and A. Churchill about the end of this month. Vol. iii. deals with the history and administration of hospitals in all countries throughout the world. Vol. iv. relates to hospital construction, and contains a bibliography and portfolio of plans.

MESSRS. R. SUTTON AND CO. have published a second edition of Mr. J. E. Gore's "Scenery of the Heavens," with stellar photographs and various drawings. Mr. W. F. Denning contributes to the volume a chapter on fireballs, shooting stars, and meteors.

THE second annual issue of "The Year-Book of Science," edited by Prof. Bonney, F.R.S., is now in a forward state of preparation, and will be shortly published by Messrs. Cassell and Company.

MESSRS. DULAU AND CO. have published "Annals of British Geology, 1891," by J. F. Blake. This is the second issue, and geologists will be unanimously of opinion that it is a decided improvement upon the first. It contains a digest of the books and papers published during the year, with occasional notes.

LECTURES on the ear will be delivered in Gresham College, Basinghall Street, E.C., on January 17, 18, 19, and 20, at 6 o'clock, by Dr. E. Symes Thompson.

IN Mr. R. Assheton's letter (NATURE, vol. xlvii. p. 176) the sentence beginning line 31 of the second column should have read thus:—"But it is more metazoic—if I may use such a word—to call the whole animal resulting from the segmentation of the fertilized ovum, the sexually produced generation."

TWO interesting new compounds are described by Prof. Anschütz, of Bonn, in the current number of the *Berichte*. They are well-crystallized compounds of the lactides derived from salicylic acid and the next higher (cresotinic) acid with chloroform, which latter substance is so loosely united with the lactide that warming to the temperature of boiling water is amply sufficient to dissociate them. Hence the compounds may be employed for obtaining perfectly pure chloroform, and for preserving chloroform in a solid form in which it is not prone to decomposition. The lactide of salicylic acid has long been supposed to be formed when the acid is treated with oxychloride of phosphorus. Prof. Anschütz, however, shows that the product of this reaction contains many other substances in addition, but by working under special conditions he has succeeded in

isolating pure salicylide. Salicylic acid is dissolved in an indifferent solvent, preferably toluene or xylene, before the addition of the phosphorus oxychloride. The product of the reaction is washed first with soda and afterwards with water. Owing to the property, discovered by Prof. Anschütz during the course of the work, which salicylide possesses of combining with chloroform, it may be extracted from the white solid product, after drying, by means of chloroform, the compound being deposited from the chloroform solution in large colourless transparent crystals belonging to the tetragonal system. The compound possesses the composition $C_6H_4.CO.O.2CHCl_3$. The chloroform readily escapes upon warming, in very much the same manner as the water of crystallization contained in many crystallized salts. The free salicylide remaining is a solid substance melting at 261°. As regards its molecular constitution it is shown, by the amount of lowering of the melting-point of phenol employed as a solvent, to contain four of the salicylic radicles $C_6H_4.CO.O$, and is probably a closed ring compound. In a precisely similar manner phosphorus oxychloride reacts with the three cresotinic acids, the acids next higher than salicylic, with formation among other substances of lactides, which may be isolated in the same way in the form of their chloroform compounds, $CH_3.C_6H_3.CO.O.2CHCl_3$. Orthocresotinic acid lends itself best to this reaction. The pure lactides are readily obtained from the chloroform compounds by warming to 100°, pure chloroform being gently evolved.

THE two substances above described, salicylide-chloroform and the corresponding compound derived from ortho-cresotinic acid, are admirably adapted for the preparation of pure chloroform, on account of their large content of the latter substance, salicylide-choloroform containing 33·24 per cent. and the cresotinic compound 30·8 per cent of its weight. Moreover, in closed vessels they may be preserved any length of time; when exposed to the open air salicylide-chloroform slowly loses its chloroform, but the cresotinic compound is well-nigh stable, even under these conditions. The same quantity of the free lactide may be used over and over again without decomposition, it being only necessary, in order to re-form the chloroform compound, to allow it to remain in contact with the chloroform to be purified for twenty-four hours at the ordinary temperature. None of the usual impurities in chloroform crystallize along with the compound, so that a perfect separation is effected. Again, it is well known that pure chloroform decomposes more or less on keeping; this loss may be avoided by storing it in the form of the lactide, and regenerating it when required by the application of a gentle heat, with the certainty of obtaining it perfectly pure.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus* ♀) from India, presented by Mr. W. Stutely; two Barbary Mice (*Mus barbarus*) from North Africa, presented by Lord Lilford; four Bearded Titmice (*Panurus biarmicus*), European; four Ani (*Crotophaga ani*) from South America; six Hog-nosed Snakes (*Heterodon platyrhinos*); a Striped Snake (*Tropidonotus sirtalis*); a —— Snake (*Pitnophis* ——), from North America, purchased.

OUR ASTRONOMICAL COLUMN.

THE MOTION OF NOVA AURIGÆ.—Prof. W. W. Campbell, of the Lick Observatory, has communicated further results relating to Nova Aurigæ to the December number of *Astronomy and Astrophysics.* He is now perfectly convinced that the variation in the velocity previously suspected is real, and probably due to orbital motion. The values given below have been calculated on the assumption that the brightest line in the spectrum of the Nova, since the reappearance in August, is really the chief nebula line. The bright lines were displaced towards the violet, indicating approach, whereas in February and March last they were displaced towards the red.

Date. 1892.		λ		Velocity of approach. Miles per sec.
Aug. 20	...	5003·6	...	128
21	...	3·7	...	125
22	...	3·7	...	125
23	...	3·1	...	147
30	...	2·4	...	173
Sep. 3	...	2·4	...	173
4	...	1·9	...	192
6	...	2·1	...	184
7	...	1·9	...	192
15	...	2·2	...	180
22	...	2·5	...	169
Oct. 12	...	3·6	...	128
19	...	3·8	...	121
Nov. 2	...	4·4	...	99
3	...	4·7	...	87

In the same journal Mr. Sidgreaves points out that the new lines cannot simply be revivals of those of February, and, further, that on account of the great difference of velocities and the reversed direction, they cannot be supposed to belong to the bright-line component of February. Neither is it likely that the dark-line component has become a planetary nebula, and the probability of three bodies rushing together being very small, Father Sidgreaves believes the new results to strengthen the view that the compound character of the spectrum was produced by local disturbances of a single star.

ASTRONOMICAL DISCOVERIES IN 1892.—In the *Observatory* for January Mr. Denning gives an excellent summary of the astronomical discoveries of 1892, a year which was very remarkable for the special attention given to the science by the press and the public. In chronological order the principal events were as follows:—

January 20.—Minor planet (324) discovered by photography by Max Wolf at Heidelberg. (Altogether 27 were discovered during the year by various observers.)

January 23–30.—Discovery of Nova Aurigæ by Dr. Anderson.

February 11.—The great sun-spot, extending over 150,000 miles of longitude, reached the sun's central meridian. This was followed by remarkable magnetic disturbances and displays of aurora.

March 6.—Comet discovered by Lewis Swift.

March 18.—Comet discovered by Denning at Bristol. On this day also, Dr. Spitaler, of Vienna, re-detected the periodical comet of Pons (1819) and Winnecke (1858).

August 6.—Opposition of Mars. Mr. Denning writes: "Practically our knowledge stands where it stood before. The results are not sufficiently discordant to settle disputed points."

August 27.—A new comet discovered by Brooks, of Geneva, N.Y.

September 9.—Prof. Barnard's memorable discovery of the fifth satellite of Jupiter.

October 12.—Comet discovered by photography by Prof. Barnard.

November 6.—Bright comet discovered in Andromeda by Mr. Edwin Holmes, London.

November 20.—A faint comet discovered by Brooks.

November 23.—Brilliant shower of shooting stars observed in Canada and the United States. The shower was evidently that of the Andromedes connected with Biela's comet.

COMET HOLMES.—Mr. Lewis Boss finds for this comet a period of 6·914 years, and concludes that no very close approach to Jupiter can have taken place in recent years; the eccentricity, however, is so small that important perturbations by Jupiter may have occurred. He further states that "the recent remarkable decrease in brightness of the comet seems to do away with the necessity of supposing that it has been recently made a member of the solar system. This decrease also renders it reasonably certain that the comet must have been subjected to some extraordinary disturbance of its internal economy, by the application of forces from without or within, with the result of giving to it that which was really an unaccustomed and temporary size and brightness" (*Astronomical Journal*, No. 283). According to Mr. Lockyer's views, such increase of brightness would be produced by the comet colliding with another meteor

swarm lying in its track, and it is quite possible that the brightening of the comet at the time of the discovery was very sudden, thus explaining why the comet was not detected earlier.

The Rev. E. M. Searle (*Astronomical Journal*, No. 283) has deduced a period fifteen days shorter than that of Mr. Boss.

M. Schulhof, of Paris, finds a period of 6·909 years. He also points out that among the known periodic comets that of De Vico shows the greatest orbital similarity to Holmes's comet, and he considers that they may possibly have a common origin.

Mr. Roberts, of the Nautical Almanac Office, accepting as real the supposed impression of the comet obtained by Mr. Schorling in a photograph of the region taken on October 18, found a period of fifteen years, but the general agreement of the latest computations seems to indicate that the image in question could not be that of the comet.

The comet is now so dim that it is not considered necessary to continue the ephemeris.

EPHEMERIS OF COMET BROOKS (November 20, 1892).—The following ephemeris of Comet Brooks (Berlin, midnight) is given in *Ast. Nach.*, No. 3140, by Kreutz :—

Date.	R A. h. m. s.	Decl. (app.) ° ′	Log r.	Log Δ.
Jan. 12 ...	21 40 18 ...	+ 59 41 ...	0·0786 ...	9·8915
13 ...	56 4 ...	58 8·1 ...	0·0791 ...	9·9012
14 ...	22 9 53 ...	56 33·6 ...	0·0797 ...	9·9114
15 ...	22 3 ...	54 59·1 ...	0·0803 ...	9·9220
16 ...	32 47 ...	53 25·7 ...	0·0810 ...	9·9330
17 ...	42 18 ...	51 54·2 ...	0·0818 ...	9·9442
18 ...	50 47 ...	50 25·2 ...	0·0826 ...	9·9556
19 ...	22 58 23 ...	48 59·3 ...	0·0835 ...	9·9670

THE METEOR SHOWER OF NOVEMBER 23, 1892.—Further observations of this fine display of shooting stars are recorded in *Astronomical Journal*, No. 283. Prof. J. K. Rees counted 165 meteors in half an hour, and noted some as bright as Mars; all of them were very swift. The Rev. J. G. Hagen estimated that one observer, with a clear view to the west would have seen 250 meteors in half an hour, and notes that some were as bright as Jupiter. Mr. Sawyer estimated the maximum frequency as about 300 per hour, and, strangely enough, describes them as "slow-moving, generally quite bright, although none were observed as bright as the planets Mars and Jupiter." Both Prof. Rees and Mr. Sawyer note that the meteors appeared in clusters, four or five falling almost at the same instant, while for a few minutes none were seen. The radiant was near γ Andromedæ, and there is little doubt that the shower was that due to Biela's comet.

GEOGRAPHICAL NOTES.

IN M. Dybowski's journey from the Mobangi to the Shari, as described at a recent meeting of the Paris Geographical Society, he encountered one of the most systematically cannibal tribes which has yet been described. This tribe, known as the Bonjos, have only one object of purchase—slaves to be eaten. They refuse to sell food or any other products of their country for anything else, and the surrounding tribes capture and export canoe-loads of slaves for this purpose. The French expedition experienced great difficulty in obtaining food amongst a people who had no desire for ordinary articles of trade.

THE boundaries of the republics of South and Central America are certainly the least definite lines on the political map of the world so far as civilized lands are concerned. The question of delimitation is never at rest. Dr. H. Polakowsky gives in the last number of *Petermann's Mitteilungen* a brief account of the negotiations and surveys relating to the frontier of Costa Rica and Nicaragua from 1858 to 1890. The difficulty in this case lies in the fact that the mouth of the San Juan river, a certain point of which was fixed on in 1858 as the coast frontier, is continually changing, and a breakwater belonging to the harbour and canal entrance of Greytown, in Nicaragua, now stands in what was formerly the territory of Costa Rica. On the Pacific coast years of diplomacy were required to fix the centre of Salinas Bay, but it is satisfactory to know that permanent boundary stones have now been erected at both ends of the line.

MR. COLES delivered his second lecture to young people under the auspices of the Royal Geographical Society, on Friday evening, when a large audience of both young and old enjoyed his spirited descriptions of Iceland and British Columbia, illuminated by many anecdotes of personal adventure.

THE defective condition of the charts, even of the coast of Europe, was strikingly brought out by the recent court-martial on the stranding of H.M.S. *Howe* in Ferrol Channel. The chart used on board was drawn from soundings made about a hundred years ago, with a few subsequent corrections, which failed altogether to indicate the rock on which the *Howe* struck. The Spanish authorities are reported to have refused permission for the new chart surveyed by the officers of the Channel Squadron to be published, and meanwhile the Hydrographic Office has cancelled the old chart.

A NEW SEISMOGRAPH.

BEFORE speaking of this memoir, let me enter a protest against the method of publishing these "Annali" in such a way as to convey the impression that the papers composing it were written three years before their actual date. All readers are warned that when the volume is bound up, and the paper covers are removed, they must post-date the papers by three years.

The seismograph described in the present paper is intended for stations of the second class. The objects in view in its construction were amplification of the record in a pendulum seismograph, and improvement of the warning apparatus in the form of a style seismoscope of the Milne type which the author finds frequently fails.

The amplifying lever is composed of fine placfont tubes arranged girder-like in the form of a short hollow triangular prism, surmounted by an acute triangular pyramid, which points downwards, and carries at its apex the writing style. The pendulum bob is a flattened cylinder, supported by a placfont wire 1·50 m. long. The amplifying lever at the junction of the three pyramidal and the prismatic tubes supports three radial arms meeting in the centre, as it were, of the pyramid base, and support a ball-and-socket joint of agate, the cup part of which is at the end of an arm projecting from the supporting wall. Immediately above this centre, and occupying the prism space of the lever, is the cylindrical box, the wire supporting which passes through a small hole in the centre of the base of the prism. We thus have a simple lever of the first order of light girder work. It is prevented from rotating in azimuth by including some steel wire permanently magnetized.

The style has been modified by lightening it and making it more rigid and non-oxidizable, which is done by using a capillary glass tube.

The registering apparatus is a smoked glass plate, supported over a clock, started at the moment of the earthquake by a seismoscope. To prevent the complex figures of the ordinary registration in a pendulum seismograph, the author has arranged so that the plate shall rotate through a segment of a circle every three seconds, so as to bring a fresh surface of smoked glass beneath the style.

Some modifications are then described. The principal one is making the bob annular, carrying a suitable aperture, in which is engaged the short end of a lever. This lever is composed of three very thin brass tubes, graduating away smaller from the fulcrum, which is a gimbal joint such as suggested by the reviewer some years since in NATURE. This lever carries at its lower and longer end the style which records on the glass plate as in the original one described in this memoir.

Another modification is a combination of the triple and single suspension of the pendulum bob, that is, the bob ring is first suspended by triple wires to a button which in its turn hangs at the end of a single wire.

The details of these seismographs are fairly well worked out, but the employment of aluminium in many of the parts has been neglected. Likewise, no arrangement has been made for the oblique play of the engaged pinion in the newer lever. The only new point about this seismograph is the interrupted rotation of the recording plate. This has a decided advantage in giving a dissected record, but is part counterblanced by the fact that important movements that may be taking place at the moment

[1] G. Agamennone, "Sopra un Nuovo Pendolo Sismografico." *Annali dell' Ufficio Centrale Meteor. e Geodinamico*, ser. sec., pt. 3, vol. xi., 1889. (Roma, 1892.)

of the advance are represented by a curve or curves which would require a series of careful experiments to be carried out in each instrument, followed by difficult and elaborate calculation for each advance.

Much credit is due to the author for working out the modifications, but until we have some original method of finding a steady-point, not so far suggested, it is doubtful if we can improve on the Gray, Ewing, and Milne seismographs, that are not, as the author imagines, little used or tested instruments.

H. J. JOHNSTON-LAVIS.

PHYSICAL GEOGRAPHY AND CLIMATE OF NEW SOUTH WALES.

A SECOND edition of an excellent pamphlet on the "Physical Geography and Climate of New South Wales," by Mr. H. C. Russell, F.R.S., astronomer royal for New South Wales, has just been issued at Sydney. It is published by authority of the New South Wales Government. The following extracts may be of interest to various classes of readers in Great Britain:—

Looking back through the pages of history, and the dim traditions of an earlier time, we find abundant evidence of a belief in the existence of a great south land to the south and east of what was then the well known earth. Those early navigators whose travels had fostered this belief, had doubtless followed down the Malay Peninsula and the string of islands which seem to form part of it, in search of spices and other treasures which the islands supplied. Pliny, who had evidently gathered up the traditions of "Terra Australis incognita," says that it lay a long way south of the Equator, and in proof of this mentions the fact, strange in those days, that when some of its inhabitants were brought to civilization they were astonished to find the sun rise on their left hand instead of on their right. And Ptolemy, A.D. 170, after describing the Malay Peninsula, says: Beyond it, to the south-east, there was a great bay in which was found the most distant point of the earth; it is called "Cattigara," and is in latitude $8\frac{1}{2}°$ south; "thence (he goes on to say) the land turns to the west, and extends an immense distance until (as he believed) it joins Africa." And it may fairly be assumed that the extreme south latitude of Cattigara, and its situation in a great bay where the land turns to the west until it joins Africa, is proof that it was some point in the Gulf of Carpentaria, for no other place would fulfil the conditions. The idea that the land actually reached Africa was not Ptolemy's; it was a necessary part of the system of Hipparchus, for he taught that the earth surrounded the water and prevented it from flowing away. It is not surprising, therefore, that the early navigators, following down the islands, came at length to that part of the Gulf of Carpentaria where the land turned to the west; and believing Hipparchus' system of geography, thought that in turning to the west they were in reality turning towards home, and Cattigara was therefore the most distant point known. Marco Polo tells us that the Chinese navigators in his day (A.D. 1293) asserted there were thousands of islands in the sea to south of them, and in the present day we find proofs of their early visits to Australia in the traces of Chinese features amongst the natives of the northern coast; indeed, some historians think that Marco Polo, in the account he gives of the expedition sent to Persia by the Great Khan, refers directly to Australia, under the name of Lochac. This place he says was too far away to be subjugated by the Great Khan, and was seldom visited; but it yielded gold in surprising quantity, and amongst other wonders contained within it an immense lake or inland sea. It is impossible that such a description should apply, as has been thought, to the Malay Peninsula,—a country within easy reach, and one which his ships must have passed in every voyage; and so far from being beyond his power, it was within the limits over which his sway extended. That Lochac formed part of the main-land was also quite in accordance with their ideas of the earth, which surrounded the ocean, and the abundance of gold is certainly more likely to be true of Australia than of the Malay Peninsula.

For long years after Marco Polo we find no direct reference to Australia, except the stories which lived amongst navigators, and seemed to lose none of their marvellous points by transmission. These kept alive the desire to explore the great south land, so rich in treasures and wonders. All the evidence collected so far goes to prove that the Portuguese had, early in the sixteenth century, explored at least the northern parts of Australia. What they learned was, however, kept a profound secret until about 1540, when one of their government maps was stolen; and there are now in existence six maps believed to be copies of it, which were all published between 1539 and 1555. These all show Australia under the name of the "Land of Java," the real Java being called the "Little Java," and from this time onward frequent attempts were made to explore what had for so many generations been "Terra Australis incognita." Sturdy navigators could not understand the silence of the Portuguese, except as proof of the richness of the land, about which tradition told wonderful tales "It was a land of gold and spices, of magnificent tropical fruits and vegetation—a perfect paradise, in which the happy and simple inhabitants were loaded with jingling ornaments of gold. Its very atmosphere was elixir, and existence a round of enjoyment." No wonder that in an age when, at least upon the ocean, the power to take was mistaken for the right to do so, there were many who cast longing glances towards the southern Paradise. Whether these stories of gold had any foundation in fact or not, when barter was regularly exchanged on the coast of Australia, it is impossible now to say, but more recent discoveries of rich surface gold lend some colour to them, and the vegetable richness of the northern part of Australia is quite in accordance with tradition. But all the early English navigators were unfortunate, and Australia got a reputation the very reverse of what further investigation has shown that it deserves. In point of fact, all the glowing colouring of tradition is true; but when Dampier, in 1688, sailed down the western coast, he saw nothing but a "dry sandy soil," and the "miserablest people in the world"; and later on, when the first English settlers landed on Australia, they chose a bay, beautiful to look at, but there was no gold and no fruit worthy of the name, the soil was barren and sandy, and the climate in the worst part of its summer. No wonder that the fame of Australia was blackened, and report made it a miserable land, subject to droughts and floods—a land in which everything was turned topsy-turvy. The summer came at winter time; trees shed their bark, not their leaves—were brown instead of green; the stones were on the outside of the cherries; and the pears, pleasant to look at, were only to be cut with an axe; and there was nothing to eat, "unless, perchance, ye'l fill ye with root of fern or stalk of lily." Such was the early verdict upon Australia. Fortunately the first colonists, once here, were obliged to stop. By degrees they found that everything that was planted grew well; that wheat in the valley of the Hawkesbury yielded 40 to 50 bushels to the acre, and in one memorable season actually ruined the farmers by its very abundance, for in the then limited market, the price fell so low that it was not worth gathering, and it was left in the fields to rot, while the farmers sought other work. Horses, sheep, cattle, and pigs throve marvellously, and some of the cows getting away, the bush soon contained numbers of wild cattle. Even wool did not deteriorate in the new Colony; and step by step the facts became too strong for prejudice, and the first fleeces of Australian sheep sent to England lifted the veil. Manufacturers would gladly take as many as could be sent; their demand for more wool extends with the supply, and now only from Australia can they obtain the fine wools which they need. Quantity and quality of wool have increased together, and the Grand Prize at the Paris Exhibition for our New South Wales wool has proclaimed the fact far and wide. Wool has done still more for the Colony. We took possession of it as a narrow strip of coast country; the demand for pasture forced us to find a way over a hitherto impassable range, and the same want has driven all the desert out of the Colony, and covered it with sixty-two millions of valuable sheep (1892). The country which early writers upon Australia called a barren waterless desert is now growing the finest wool and yielding abundant water from wells, and when, in 1851, it was announced that gold had been discovered in abundance, the world was convinced that Australia was a promising country after all. Year by year the people have been coming in increasing numbers to supply our great want (population), and as our numbers increase new avenues of wealth and prosperity are opening before us.

Geographically, Australia has a grand position, lying between the 10th and 40th degrees of south latitude—that happy mean where it is neither too hot nor too cold. Surrounded by the ocean, the sea breezes temper what might otherwise be a hot climate in the summer; the air is clear and dry, and yet brings rain in heavy showers. Vegetation is abundant, and includes

all the cereals and fruits of the world, so that, in the words of the old tradition, it has "all the conditions which make life a pleasure."

Australia measures from north to south 1900 miles, and from east to west 2400 miles, and speaking generally, has a rounded outline, the only great inlets on the coast-line being the Gulf of Carpentaria and the Australian Bight. The total area is rather greater than that of the United States, and almost equal to the whole of Europe. On the east, north, and west, and at a short distance from the coast are found ranges of mountains, of no great elevation, yet almost the only high land. On the west and north-west coasts the mountains form a bold outline of granite, rarely more than 200 miles from the coast, and attaining to heights of 2000 to 3000 feet. Between these and the sea the land is low and good, but on the inland side is found a vast table land which slopes towards the unknown interior so gradually that the inclination is not easily seen, and no rivers running to the interior have yet been discovered—all known streams running to the sea.

On the east coast we have also the mountain chain parallel to the coast, but it is much higher and more extensive, and the strip of low land by the coast is much narrower, often not more than 30 miles wide, and at Point Danger the range comes right to the sea. This grand chain of mountains is known generally as the Great Dividing Range, and extends for about 1500 miles along the east coast. Near its southern extremity is the Snowy Range, the only spot in Australia where snow may always be found. The highest peak, Mount Kosciusko, 7170 feet, is also the highest land in Australia. The ravines on its sides always contain snow, and the mountains near it, about 6000 feet high, are also covered with snow for the greater part of the year.

Of this great continent island, the Colony of New South Wales holds the choicest portion—the southern part of the east coast—the part where, with remarkable sagacity, the first settlement was made. It has the best climate, all the most important rivers in Australia, the great bulk of the coal land, unlimited stores of all the useful minerals, and the finest pastoral and agricultural lands for extra-tropical vegetation; besides which, its extensive highlands afford climatic conditions for all purposes. It is naturally divided into three portions. The comparatively narrow coast district, from 30 to 150 miles wide, abundantly watered by rivers and smaller streams coming down from the mountains. The rainfall here, fed by winds from the Great Pacific Ocean, is very abundant, from 40 inches in the south to 70 in the north, and at Sydney 50 inches. The mountains have doubtless very much to do with this abundant precipitation, and at times the rains are so heavy that the rivers, fed by mountain torrents, carry heavy and dangerous floods. In years past wheat was largely and profitably grown, but rust has of late so frequently appeared that little or no wheat is grown, for it pays better to supply the city markets with dairy produce, Indian corn, and various kinds of hay. In the northern districts sugar-growing is a profitable industry, and increasing rapidly. About Sydney enormous quantities of oranges are grown for exportation.

The second division includes the mountains and elevated plains, and extends the whole length of the colony, varying in width from 120 to 200 miles. On the south, with the exception of the Monaro Tableland, the country is very rough and mountainous, the highest points, Mount Kosciusko and the Snowy Range, catch the rain and snow that feed the river Murray and the Murrumbidgee. Wheat grows well here, but nearly all the land is used for pastoral purposes. Proceeding northwards, the mountains decrease in height and extend laterally. A part of the land is taken up for agriculture, some for mining. In its natural state the western country is open plain or lightly-timbered, and large areas are covered with rich volcanic soil which seems fit to grow anything, but the want of labour and carriage, and the profit and security to be found in raising wool and meat, has for the most part tempted capital into squatting pursuits; but since the railway has reached this part of the country more attention is being given to agriculture, and it is rapidly extending. Between Goulburn and Bathurst, the western waters form the Lachlan and the eastern the Hawkesbury rivers, and from Bathurst northwards to latitude 25° all the western waters go to form the various tributaries of the Darling river. These mountains are from 2000 to 3000 feet, with some peaks rising to nearly 6000 feet. The central parts of the western slopes are celebrated for rich soil and herbage, and here also the greater part of the gold-mining area, as well as mines for other minerals have been found, including coal, which is also found in great abundance, with iron and lime, at Lithgow and other places. Deposits of copper, silver, lead, tin, and mercury are also found in abundance. A very large portion of the high land here is suitable for agriculture, and is being taken up for that purpose by degrees. English fruits—the apple, cherry, currant, &c.—grow to perfection here, as well as in other parts of the mountain districts.

The third division covers by far the greatest area, and consists of the Great Western Plains, extending away to the Darling river, and thence to the south Australian border. Here there are but few known mineral deposits except copper, and the enormous deposits of silver and lead at Broken Hill, and no attempt at agriculture. All the land may be said to be held for grazing purposes, and for that purpose, now that capital has been invested in tanks and wells for water supply, this country is unequalled. Sheep and cattle thrive in a remarkable degree, and form a most profitable investment, the climate being dry and wonderfully healthy for man and beast.

These are the three great natural divisions, made so by the conformation of the land and the climate. It will be evident from what has been said of the elevation of the mountains that snow is not a common feature upon them, and the only part where snow lies for any considerable time is the extreme south. As a necessary consequence, the river system is peculiar; indeed, it has often been asserted that Australia had no rivers—at least none which were of any use as such; but as we shall presently see, this statement, like many others affecting Australia, was made in ignorance. The necessity for increased pasture had driven the early colonists to cross the Great Dividing Range, aptly so-named, in search of pasture, in 1815, and the desire to extend the new pastures beyond the Bathurst Plains, which were the first discovered, led them on, and one of the first questions that demanded their attention was to account for the direction in which all the streams were flowing. The shortest road to the sea was to south-west, and yet all the water was running to north-west, and quite naturally it was asked—Could there be a great inland sea into which these rivers discharged? In 1818 Oxley started with a determination to see where at least one of them went to; so he followed the Macquarie for more than 200 miles, and found that he was going due north-west, further and further, as it seemed to him, from the natural outlet on the south coast. At last the river spread out to an apparently interminable marsh. Turn which way he would his progress was stopped by a shallow fresh-water sea, for sea he was at last convinced it must be, so great was its extent, and he was obliged to turn back. He had got there after two very wet seasons (1817 and 1818), and his inland sea is now known as the Macquarie Marshes; and the mystery was not solved until Sturt, in 1829, found all these streams trending to north-west unite in the Darling, and then turn to south-west.

Coming from mountains of such moderate elevation, these streams are necessarily dependent upon the rainfall, and have no snow to help them, so that in rainy seasons they become important rivers and in dry ones sink into insignificance; but since most of the rains which feed these waters are, as it were, offshoots of the tropical rains, they seldom fail altogether, and as a rule the Darling is navigable for four months of each year, and sometimes all through the year, up to and beyond Bourke. The current is very slow, seldom reaching two miles per hour, and therefore offers little hindrance to the steamers which carry wool and stores.

In the exploration of our rivers there was another surprise when settlement extended south-west from Sydney. The waters here were found to flow to the west, and the Lachlan has for a considerable portion of its course a south-west direction, that is, at right-angles to the Macquarie and the Bogan. Could the Lachlan, the Murrambidgee, and the snow-fed Murray ultimately join the waters that ran north-west from Bathurst? Sturt had not solved this question—he only followed the Darling part of the way down—and it was left for Sir Thomas Mitchell to find the junction of the two river systems in 1835, and to prove that the Darling and the Murray were united at and below Wentworth.

After dealing with the rivers and harbours of New South Wales, Mr. Russell discusses the temperature, rainfall, droughts, and winds of the colony. Of the temperature he says:—

In works of reference, Australia generally is credited with heat in excess of that due to its latitude. It is difficult to say why, unless it arose from a habit of one of our early explorers who carried a thermometer and carefully published all the high, and none of the low readings he got, until, fortunately for the colony, the thermometer was broken and the unfair register stopped. But not only the interior—Sydney even to the present day is credited, in standard works of reference, with a mean temperature of 66·2°, or more than three degrees higher than the true mean, which is 62·9°. Such an error is not excusable when meteorological observations have been taken and published for just forty years. There is another error made by some writers when describing Australia. It is shown by them inverted on the corresponding latitudes in Europe, and the reader naturally infers that Australia is as hot as those parts of Europe. Confining our attention to New South Wales, that is between 29° and 37° of south latitude, we find that generally it is cooler than a corresponding part of Europe. The mean temperature of the southern parts of England is about 52°, and that of France, near Paris, about the same, increasing as you go south to 58·5° at Marseilles. Taking this as a sample of the best part of Europe, let us see how the mean temperatures in the colony compare with those: Kiandra, our coldest township, situated on a mountain, is 46°; Cooma, on the high land, 54°; Queanbeyan, high land, 58°; Goulburn, high land, 56°; Armidale and New England district, 56°; Moss Vale, 56°; Kurrajong, 53°; Orange, 55°. These towns are scattered along the high table-lands from south to north, and represent fairly the climate of a very considerable portion of the whole colony. Next to this in point of temperature is the strip of land between the ocean and the mountains, and which is affected by the cooling sea-breezes. Here we have a mean temperature ranging from 60° at Eden, the most southern port, to 68° at Grafton, one of the northern ports. Sydney, in latitude 34°, has a summer temperature only four degrees warmer than Paris, which is in latitude 49°. Now the usual difference for a degree in latitude is a degree in temperature, and therefore, if Sydney were as much warmer than Paris as its latitude alone would lead us to expect, its temperature should be 74°, and that is 15° warmer than Paris; but as we have seen, it is only 4° warmer. This single example is enough to prove the comparative coolness of our coast districts. The investigation made during recent years shows that the mean temperature of the whole colony, as derived from forty-five stations scattered over it, is 59·5°, three degrees lower than that of Sydney, or only one degree hotter than that of Paris.

It may be mentioned that the highest shade temperature ever recorded in Sydney was 106·9°, and near Paris a temperature of 106·5° has been recorded.

The third great district, consisting of lower land and plains to the west of the mountains, has a climate considerably warmer in summer than the parts above described, owing to the powerful effect of the sun on land having little forest and little or no wind; but in winter the temperature sinks down much lower than the coast districts, owing to the great radiation; so that the annual mean temperature is not so great as the summer heats would lead one to anticipate. A table has been prepared for the purpose of showing by comparison with many places in Europe and America the temperature of the colony. The places have been arranged in order of temperature, taking for that purpose the mean annual temperature. This shows at once that the range of temperature here is equivalent to that offered by Europe from the north of England through France to Sicily. Such a range is more remarkable, because if New South Wales were placed on the map of Europe according to its latitude it would extend from Sicily to Cairo, whereas when placed by its temperature it stretches as we have seen from Sicily northwards to England. Nor is this all that the table shows us. For even when we find a place in Europe with a temperature equal to that of some place here, it is at once observed that the summer temperature in Europe is warmer than the colonial one and the winter colder; for instance, Naples, 60·3°; Eden, 60·3°; summer at Naples, 74·4°; at Eden, 67·9°; winter at Naples, 47·6°; Eden, 51·9; and so generally the southern country has the cooler and more uniform temperature. It is worthy of remark that the only places here of equal mean and summer temperature with places in Europe are those which are to be found on the western plains, as at Wagga Wagga, which has a mean temperature of 60·3°; Naples, 60·3°; and summer temperature of both is 74°; or again, to compare the places of the same or nearly the same latitude, Messina, in Sicily, latitude 38° 11′, has a mean temperature of 66°, summer 72·2°, winter 55°; Eden, New South Wales, in latitude 37°, has a mean temperature of 60·3°, summer 67·9°, winter 51·9°; or Cairo, in latitude 30°, mean of 72°, summer 85·1°, winter 58·2°; Grafton, latitude 29° 45′, mean 68·1°, summer 76·8°, winter 58·4°. It is useless to multiply examples,—we have here enough to show how much cooler Australia really is than the fervid imaginations of some writers have made it appear in print.

Looking at this question of temperature generally, it will be seen that New South Wales is no exception to the general deduction of science that the southern lands are cooler than those of corresponding latitudes in the north, and it is only during hot winds, which are very rare in New South Wales, that the temperature rises to extremes. But to leave Europe, and compare the climate of New South Wales with that of America. Our limits of latitude would place us from Washington to New Orleans. Now the mean temperature at Washington is 55° and at New Orleans 68°, while that of Eden is 60·3° and Grafton 68·1°; so that if mean temperature were a complete test of climate it would appear that our coast is hotter than corresponding latitudes in America. But mean temperature is not enough; we must compare the summer and winter temperatures; and summer at Washington rises to 76·7° and at Eden only to 67·9°, 9° cooler; New Orleans summer is 82° and Grafton 76·8°; but 82° hardly represents the summer heat at New Orleans, for it is a steady broil, during which every day for three months of summer the heat is over 80°, a temperature that is only reached on this coast during hot winds, or in other words, very seldom. But winter temperature at Washington falls to 37·8°, and at New Orleans to 56°; at Eden 51·9°, and at Grafton 58·4°. Hence it is evident that on this coast the heat is very much less in summer and greater in winter than upon the coast of America. Such facts place the colony in a very different position in regard to climate from that which it has occupied in published works, for instead of being a hot country we see that its coast districts are much cooler than corresponding latitudes in Europe and America, and that in its elevated districts, which comprise a large part of it and much of the best land, it has a climate no warmer than the best and most enjoyable parts of Europe in much higher latitudes; but while bringing these facts into due prominence it is not the intention to deny that another considerable part of the colony, forming the western plains, is subject to greater heat, caused, no doubt, by the sun's great power on treeless plains, and the almost total absence of cooling winds; yet, although in summer the temperature here frequently rises over 100°, and sometimes up to 120°, yet, owing to the cold at night and in winter, the mean temperatures are not greater than those of corresponding latitudes in the northern hemisphere; and this part of the colony being remarkably dry, the great heat is by no means so enervating as a temperature of 80° in the moist atmosphere of the coast, and, what is of still more importance, it does not produce those terrible diseases which are usually the offspring of hot countries. This is also, no doubt, due to the dryness of the air. Stock of all kinds thrive remarkably well, and are very free from disease in those hot western districts.

SCIENTIFIC SERIALS.

THE *Quarterly Journal of Microscopical Science* for August 1892 contains:—On the anatomy of *Pentastomum teretiusculum* (Baird), by Prof. W. Baldwin Spencer, M.A. (Plates i. to ix.). Whilst collecting on Kings Island, which lies to the west of Bass Straits, half-way between the mainland of Victoria and Tasmania, numerous specimens of the copper-head snake (*Hoplocephalus superbus*) were found, in the lungs of which a large species of Pentastomum were parasitic; afterwards the same parasite was discovered in the lungs of the black snake (*Pseudechys porphyriacus*) in Victoria; on examination there seemed little doubt but that the species was the one described by Baird long ago (1862) from specimens obtained in the mouth of a dead copper-head snake in the Zoological Gardens, London, under the name of *Pent. teretiusculum*. In this paper we have a very complete account of the anatomy of this form, there being descriptions and figures of its external anatomy, schematic

representations of the muscular, alimentary, secretory, nervous, and reproductive systems, and an account of the sense organs. The paper is illustrated by ten double plates.—On the minute structure of the gills of *Palæmonetes varians*, by Edgar J. Allen, B.Sc. (Plate x.). It would seem that so far as the gills of this crustacean are concerned, the statement made by Haeckel and Ray Lankester, that the circulatory system of the Decapods is everywhere closed, does not hold true. It would also seem fairly certain that the masses of cells surrounding the venous channels, in which Kowalevsky found litmus deposited a few hours after its injection, exercise an excretory function. In addition to these excretory cells, a large number of glandular bodies occur in the axis of the gill, and these are of two kinds—clear and reticulate glands.

The number for November 1892 contains:—On the development of the optic nerve of vertebrates, and the choroidal fissure of embryonic life, by Richard Assheton, M.A. (Plates xi. and xii.). That the optic nerve is formed by the differentiation of the cells of the optic stalk into nerve fibres, which consequently lose connection with the inner wall of the optic cup, and piercing the outer wall, make connection with the outer face thereof, is held to be probable by such writers as Balfour, Foster, Marshall, Haddon, and others, whilst the opinion that it is formed by the growth of nerve fibres either from the retina (outer wall of the optic cup) or from the brain, along the optic stalk, but outside it and unconnected with it, is or has been held by His, Müller, Kolliker, Hertwig, Orr, and has been recently supported by Keibel, Froriep, and Cajal. Schäfer seems to be uncertain which view to take. As the result of the author's investigations in the frog and chick, he concludes that the optic stalk takes no part in the formation of the nervous parts of the organ of sight. The optic nerve is developed independently of the optic stalk, and at first entirely outside it. The great majority of the fibres forming the optic nerve arise as outgrowths from nerve cells in the retina.—On the larva of *Asterias vulgaris*, by George W. Field, M.A. (Plates xiii. to xv.).—On the development of the genital organs, ovoid gland, axial and aboral sinuses in *Amphiura squamata*; together with some remarks on Ludwig's hæmal system in this ophiurid, by E. W. MacBride, B.Sc. (Plates xvi. to xviii.). Concludes that echinoderms agree with other cœlomata in the origin of their genital cells these latter have at first an unsymmetrical position in echinoderms, and afterwards take on a radially symmetrical disposition in correspondence with the secondarily acquired radial form of the body. The origin of these cells adjacent to the stone canal suggests a comparison of the origin of the genital cells near the nephridia in many annelids, but the homology of the stone canal with a nephridium has yet to be proved.—On a new genus and species of aquatic Oligochæta belonging to the family Rhinodrilidæ, found in England by W. B. Benham, D.Sc. (Plates xix. and xx.). This new worm receives the name of *Sparganophilus tamesis*; it was found in some numbers in the mud of the Thames, adhering to the roots of *Sparganium ramosum*, near Goring; the cocoon is drawn out to a point at one end, while in the other it shows a narrow frayed end. As the home of the Rhinodrilidæ is America, the author suggests that the cocoons of this worm may have been introduced into the Thames amongst the roots of water plants, or attached to timber from the United States.

American Meteorological Journal, December.—Atmospheric electricity, earth currents, and terrestrial magnetism, by Prof. C. Abbe. The author has collected from various telegraph companies particulars about electrical storms, which illustrate the magnitude of the disturbances that frequently occur. The present electrical and magnetic observatories, which usually observe only some part of the whole series of phenomena, need to be supplemented by completely equipped establishments recording continuously the north-south, the east-west, and the zenithal-antipodal differences of potential. The ordinary records of atmospheric electricity give merely the difference of potential of the earth and a point in the atmosphere defined as the end of the water-dropping collector.—Notes on the use of automatic rain gauges, by J. E. Codman. Observations were made continuously for three years with the object of showing what difference the size of the gauges would make in the amount of rainfall collected. The largest gauge had a diameter of over 22 inches, and the smallest 2 inches. The results show that the size of the gauge made no practical difference. He also gives the results of rainfall collected in gauges erected at various heights on a mast. The result showed that a gauge at an elevation of 50 feet or less above the surface of the ground will collect the same amount as one on the ground, provided both are situated in a position not affected by counter-currents of air. This result agrees with that found by Prof. Hellmann in his experiments at Berlin.—Sunshine recorders, by Prof. C. F. Marvin. Thus far two methods only have been in general use, (1) the focussing of the rays of the sun by means of a glass sphere and obtaining a burn on the surface of a card, and (2) the photographic method, producing a trace on sensitized paper. The first method records only bright sunshine, while the latter method is more sensitive and records fainter sunshine. Prof. Marvin has improved a method first developed by D. T. Maring of the Weather Bureau, consisting in principle of a Leslie differential air thermometer, mercury being used to separate the air in the two bulbs. When properly adjusted and exposed to sunshine the lower blackened bulb becomes heated and causes the column to rise above a platinum point and close an electric circuit. The instrument, of which a drawing is given, is said to respond promptly to sunshine and shadow. The other articles are:—Late investigation of thunderstorms in Wisconsin, by W. L. Moore.—Observations on the aurora of July 16, by T. W. Harris, and Temperature sequences, by Prof. H. A. Hazen.

THE articles in the *Journal of Botany* for November and December are mostly of interest to students of British botany. Mr. F. J. Hanbury adds two more to his new species of *Hieracium*, *H. britannicum* and *H. caniceps*; Mr. Bagnall describes a new species of bramble, *Rubus mercicus* from the Midland counties; and Mr. W. H. Pearson a new British liverwort, *Scapania aspera*. Mr. G. F. Scott Elliot contributes some useful hints on botanical collecting in the tropics.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 8, 1892.—"On the Photographic Spectra of some of the Brighter Stars." By J. Norman Lockyer, F.R.S.

The present communication consists of a discussion of 443 photographs of the spectra of 171 stars, which have been obtained at Kensington and Westgate-on-Sea during the last two years.

The chief instrument employed in this work has been a 6-inch refracting telescope in conjunction with—at different times—objective prisms of $7\frac{1}{2}°$ and $45°$ respectively.

By this method the time of exposure is short, and good definition, with large dispersion, is easily secured. The spectra thus obtained will bear enlargement up to thirty times without much sacrifice of definition.

The 30-inch reflector and slit-spectroscope at Westgate-on-Sea have also been used in the inquiry.

My object has not been so much to obtain photographs of the spectra of a large number of stars as to study in detail the spectra of comparatively few.

In the classifications of stars adopted by others from a consideration of the visual observations, only the broader differences in the spectra have been taken into account. Prof. Pickering has more recently employed a provisional classification in connection with the Henry Draper Memorial photographs of stellar spectra, but this chiefly relates to photographs taken with small dispersion. With larger dispersion it becomes necessary to deal with the presence or absence of individual lines.

In the first instance, the various stars of which the spectra have been photographed at Kensington have been arranged in tables, without reference to any of the existing classifications, and taking into account the finer details. The basis on which the main tabular divisions of the spectra are founded is the amount of continuous absorption at the blue end. This distinction was not possible in the case of the eye observations.

The stars included in the first table are characterized by the absence of any remarkable continuous absorption at the blue end, and by the presence in their spectra of broad lines of hydrogen. These have been further classified in four sub-divisions, depending on the presence or absence of other lines.

In the stars of the second table there is a considerable amount of continuous absorption in the ultra-violet, and the spectra beyond K are very difficult to photograph as compared with the stars of the first table. In these stars the thickness of the hydro-

gen lines is about the same as in the solar spectrum. These also are arranged in two sub-divisions.

In all the stars included in the third table there is a very considerable amount of continuous absorption in the violet, extending to about G, and it is a matter of great difficulty to photograph these spectra, as most of the stars of this class are below the third magnitude. The hydrogen lines are very thin. One subdivision includes the spectra which show flutings shading away towards the less refrangible end of the spectrum. The other comprises stars without flutings in their spectra. The brightest star in this table, α Orionis, is discussed in detail, the result tending to show that the temperature of the absorbing iron vapours is not much greater than that of the oxy-hydrogen flame.

The relations of the various sub-divisions to which reference has been made are then traced.

One important fact comes out very clearly, namely, that whether we take the varying thicknesses of the hydrogen lines or of the lines of other substances as the basis for the arrangement of the spectra, it is not possible to place all the stars in one line of temperature. Thus, there are stars in which the hydrogen lines are of the same average thickness, while the remaining lines are almost entirely different. These spectra cannot, therefore, be placed in juxtaposition, and it is necessary to arrange the stars in two series.

The next part of the paper consists of a discussion of the photographic results in relation to the meteoritic hypothesis. In the Bakerian Lecture for 1888, I brought together the various observations of the spectra of stars, comets, and nebulæ, and the discussion suggested the hypothesis that all celestial bodies are, or have been, swarms of meteorites, the difference between them being due to different stages of condensation. The new classification rendered necessary by this hypothesis differed from previous ones, inasmuch as the line of evolution followed, instead of locating the highest temperature at its commencement, as demanded by Laplace's hypothesis, placed it much later. Hence bodies of increasing temperature were demanded as well as bodies of decreasing temperature.

The question how far this condition is satisfied by the new facts revealed by the photographs is next discussed.

This involves the consideration of some points in connection with the hypothesis to which brief reference alone has been made in previous communications. The phenomena to be expected on the hypothesis, and the actual facts, are given side by side below :—

Nebulæ.

The bright lines seen in nebulæ should have three origins :—	
(1) The lines of those substances which occupy the interspaces between the meteorites. Chief among these, from laboratory experiments, we should expect hydrogen and gaseous compounds of carbon.	(1) Lines at wave-lengths approximately very closely to the lines of hydrogen, and to some of the carbon flutings, appear in the spectra of nebulæ.
(2) The most numerous collisions between the meteorites will be partial ones—mere grazes—sufficient only to produce comparatively slight rises of temperature.	(2) There is a fluting most probably due to magnesium at λ 500, and the longest flame lines of iron, calcium, and magnesium are seen.
(3) There will, no doubt, be a small number of end-on collisions, producing very high temperatures, and there should be evidence of some high-temperature lines.	(3) The chromospheric line D_3 and another line at λ 4471 (which is always associated with D_3 in the chromosphere) have been recorded in the spectrum of the Orion Nebula.

Bright-Line Stars.

The lines seen in the spectra of bright-line stars should, in the main, resemble those which appear in nebulæ. They will differ, however, for two reasons given in the paper.	Prof. Pickering has shown that the Draper Memorial photographs prove that bright-line stars are intimately connected with the planetary nebulæ, the lines in the spectra being almost identical.

Stars of Increasing Temperature.

Stage 1.—Immediately following the stage of condensation giving bright-line stars, the bright lines from the interspaces will be masked by corresponding dark ones, due to absorption of the same vapours surrounding the incandescent meteorites, and these lines will therefore vanish from the spectrum.	The spectra of stars given in the third table answer these requirements. They show no bright lines under normal conditions.
Owing to the interspaces being restricted, absorption phenomena will be in excess, and low-temperature metallic fluting absorption will first appear. The radiation spectrum of the interspaces will now consist chiefly of carbon.	The dark flutings in the visual spectrum agree very closely in position with the flutings seen in the flame spectra of manganese, lead, and iron. The evidence afforded by the photographs proves the actual presence of carbon radiation.
Under these conditions the amount of continuous absorption at the blue end will be at a maximum.	The photographs show a considerable amount of continuous absorption in the ultra-violet and violet.
Stage 2.—With further condensation, the radiation spectrum of the interspaces will gradually disappear, and dark lines replace the fluting absorption owing to increase of temperature, though this line absorption need not necessarily resemble that in the solar spectrum.	The spectra consist of numerous dark metallic lines, but they do not exactly resemble the solar spectrum. α Tauri and γ Cygni are types of stars at this stage.
Stage 3.—(1) The line absorption and the continuous spectrum at the blue end will diminish as the condensations are reduced in number, as only those vapours high up in the atmospheres surrounding the condensations will be competent to show absorption phenomena in consequence of the bright continuous spectrum of the still disturbed lower levels of those atmospheres.	(1) These conditions are satisfied by such stars as α Cygni, Rigel, Bellatrix, δ Orionis, and α Virginis. In these there is no continuous absorption at the blue end, the spectra consisting of simple line absorption.
(2) Lines of iron and other substances will disappear at this stage, because the bright lines from the interspaces will counteract the lines in the same positions due to absorption of surrounding vapours.	(2) In the spectrum of α Cygni, which represents the earliest example of this stage, there are a few of the longest lines of iron, but in other stars of this class the iron lines disappear.
(3) The chances of violent collisions being now enormously increased, we should expect the absorption of very high-temperature vapours. The solar chromospheric lines may be taken as examples of lines produced at such temperatures.	(3) The new lines which appear include the chromospheric line at λ 4471, and possibly a few others.

The Hottest Stars.

The order of the absorbing layers should follow the original order of the extension of the vapours round the meteorites in the first condition of the swarm, and the lines seen bright in nebulæ, whatever their origins may be, should therefore appear almost alone as dark lines.	In stars like α Andromedæ we have absorption lines agreeing in position with some of the bright lines which appear in nebulæ.

Stars of Decreasing Temperature.

Stage 1.—Owing to the diminishing depth of the absorbing atmosphere, the hydrogen lines will, on the whole, get thinner, and new lines will appear. These new lines will not necessarily be identical with those observed in the spectra of stars of increasing temperature. In the latter there will be the perpetual explosions of the meteorites affecting the atmospheres, whereas in a cooling mass of vapour we get the absorption of the highest layers of vapours. The first lines to appear, however, will be the longest low-temperature lines of the various chemical elements.

Taking Sirius as a type of stars in the first stage of decreasing temperature, it is found that its spectrum shows many of the longest lines of iron.

Stage 2.—The hydrogen lines will continue to thin out, and the spectra will show many more of the high-temperature lines of different elements. These will differ from the lines seen in stars of increasing temperature owing to the different percentage composition of the absorbing layers, so far as the known lines are concerned.

The conditions at this stage of cooling are satisfied by such stars as β Arietis and α Persei. In the spectrum of these stars nearly all the solar lines are found, in addition to fairly broad lines of hydrogen.

Stage 3.—With the further thinning out of the hydrogen lines and reduction of temperature of the atmosphere, the absorption flutings of the compounds of carbon should come in.

There is undoubted evidence of the presence of carbon absorption in the solar spectrum and the spectrum of Arcturus, the only star which has yet been investigated with special reference to this point.

The photographs, then, give us the same results as the one formerly obtained from the eye observations.

Comparison is then made between the groups in the classification first suggested by the eye observations, and the various sub-divisions in which the photographs have been arranged.

Geological Society, December 7.—W. H. Hudleston, F.R.S., President, in the chair.—The following communications were read :—Note on the Nufenen-stock (Lepontine Alps), by Prof. T. G. Bonney, F.R.S. In 1889 the author was obliged to leave some work incomplete in this rather out-of-the-way portion of the Lepontine Alps. In the summer of 1891 he returned thither in company with Mr. J Eccles, F.G.S., and the present note is supplementary to the former paper. The Nufenen-stock was traversed from north to south, and a return section made roughly along the eastern bank of the Gries Glacier. Gneiss abounds on the north side of the Nufenen Pass, followed by rauchwacké and some Jurassic rock. On the flank of the mountain are small outcrops of rauchwacké and of the so-called "Disthene-schists" (both badly exposed), followed by much Dark-mica schist, often containing black garnets. Higher up is a considerable mass of Jurassic rock with the "knots" and "prisms" which have been mistaken for garnets and staurolites, but Dark-mica schists set in again before the summit is reached. They continue down the southern flank of the peak : but rather north of the lowest part of the water-shed, between Switzerland and Italy, the "Disthene-schist" is again found, followed by a fair-sized mass of rauchwacké. The return section gave a similar association in reverse order ; and both confirmed the conclusions expressed by the author in 1890 as to the absence of garnets and staurolites from Jurassic rocks (with belemnites, &c.), and the great break between these or the underlying rauchwacké (where it occurs) and the crystalline schists, in which garnets often abound, of the Lepontine Alps The crystalline schists and the Mesozoic rocks are thrown into a series of very sharp folds, which, locally, presents at first sight the appearance of interstratification.—On some schistose "greenstones" and allied hornblendic schists from the Pennine Alps, as illustrative of the effects of pressure-metamorphism, by Prof. T. G. Bonney. The author describes the results of study in the field, and with the microscope, of (*a*) some thin dykes in the calc-schist group, much modified by pressure ; (*b*) some larger masses of green schist which appear to be closely associated with the dykes ; (*c*) some other pressure-modified greenstone dykes of greater thickness than the first. The specimens were obtained, for the most part, either near Saas Fee or in the Binnenthal. These results, in his opinion, justified the following conclusions :—(1) That basic intrusive rocks, presumably once dolerites or basalts, can be converted into foliated, possibly even slightly banded, schists, in which no recognizable trace of the original structure remains. (2) That in an early (possibly the first) stage of the process, the primary constituents of the rock-mass are crushed or sheared, and thus their fragments frequently assume a somewhat "streaky" order ; that is to say, the rock passes more or less into the "mylonitic" condition. (3) That next (probably owing to the action of water under great pressure) certain of the constituents are decomposed or dissolved. (4) That, in consequence of this, when the pressure is sufficiently diminished, a new group of minerals is formed (though in some cases original fragments may serve as nuclei) (5) That of the more important constituents hornblende is the first to form, closely followed, if not accompanied, by epidote ; next comes biotite (the growth of which often suggests that by this time the pressure is ceasing to be definite in direction) ; and, lastly, a water-clear mineral, probably a felspar, perhaps sometimes quartz. (6) That in all these cases the hornblende occurs either in very elongated prisms or in actual needles. The author brings forward a number of other instances to show that this form of hornblende may be regarded as indicative of dynamometamorphism ; so that rocks where that mineral is more granular in shape (cases where actinolite or tremolite appears as a mere fringe being excepted) have not been subjected to this process.—On a secondary development of biotite and of hornblende in crystalline schists from the Binnenthal, by Prof. T. G. Bonney. Both the rocks described in this communication come from the Binnenthal, and were obtained by Mr. J. Eccles, F.G.S., in the summer of 1891. They belong to the Dark-mica schists described by the author in former papers, and have been greatly affected by pressure. In each a mineral above the usual size has been subsequently developed. In the rock from near Binn this mineral is a biotite : the dimensions of one crystal, irregular in outline, and having its basal cleavage roughly perpendicular to the lines indicative of pressure, are about $\cdot 175'' \times \cdot 03''$. The other mineral, from the peak of the Hohsandhorn, is a rather irregularly-formed hornblende, the crystals (which lie in various directions) being sometimes more than half an inch long. The exterior often is closely associated with little flakes of biotite. The author discusses the bearing of this fact, and the circumstances which may have favoured the formation of minerals, so far as his experience goes, of an exceptional size. Some remarks also are made on relation of these structures developed in the Alpine schists to the various movements by which those rocks have been affected, and on the general question of pressure as an agent of metamorphism. The reading of these papers was followed by a discussion, in which the President, Mr. Eccles, the Rev. E. Hill, Mr. Rutley, Mr. Teall, and the author, took part.—Geological notes on the Bridgewater District in Eastern Ontario, by J. H. Collins.

PARIS.

Academy of Sciences, January 2.—M. d'Abbadie in the chair.—M. Lœwy was elected Vice-President for 1893. MM. Fizeau and Fremy were elected into the central committee of administration. The President gave a list of the members, associates, and correspondents deceased and elected during 1892. The new members were MM. Appell, Perrier, Guyon, and Brouardel. Foreign associates, MM. von Helmholtz, and van Beneden. Correspondents, MM. Sophus Lie, Considère, Amsler, Auwers, Rayet, Perrotin, de Tillo, and Manen.—Observations of Brooks's comet (November 19, 1892) made with the *equatorial coudé* of the Lyon Observatory, by M. G. Le Cadet.—On a new method of approximation, by M. E. Jablonski.—On the movements of systems whose trajectories admit of an infinitesimal transformation, by M. Paul Painlevé.—On the general form of vibratory motion in an isotropic medium, by M. E. Mercadier.—On thermo-electric phenomena between two

electrolytes, by M. Henri Bagard. The thermo-electric force between two portions of the same electrolyte in different stages of dilution was determined by experiments performed at the physical laboratory of the Faculty of Sciences at Nancy. The diaphragm employed consisted of goldbeater's skin, which has the advantage of closely adhering to the glass. The results are given in the case of zinc sulphate. With a 5 per cent. and a 45 per cent. solution the difference of potential ranged from 78 at 17·9° to 155 at 73·5°, the unit being 1/10000th of the E.M.F. of a Daniell cell. The law of intermediate bodies was strictly fulfilled, as shown by opposing a couple of 5 and 25 per cent. in series with another of 25 and 45 per cent. to a third of 5 and 45 per cent., when no deflection of the electrometer was observed between 0° and 73 3°.—On the age of the most ancient eruptions of Etna, by M Wallerant. The first eruptions of Etna have been variously estimated to have occurred in the later quaternary or in the upper pliocene periods. These conclusions were based on the study of the prismatic basalt laid bare by the sea round the foot of the cone. The pliocene deposits found in conjunction with part of the basalt appear from palæontological evidence to be contemporaneous with the sub-Appenine blue marls, which belong to the lower pliocene. In the Cyclopean Isles the basalt is covered with a layer of clay, which is also found interpenetrated by the basalt. The identity of age of the two formations is evidenced by lenticular patches of sand interstratified in the clay, whose particles consist of fragments of pyroxene, peridote, and triclinic felspar, proving that when the sub-Apennine marls were being deposited Etna was the scene of eruptions accompanied by the emission of ashes.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, JANUARY 12.

MATHEMATICAL SOCIETY, at 8.—On the Application of Clifford's Graphs to Ordinary Binary Quantics, 2nd Part, Seminvariants: The President.—On the Evaluation of a Certain Surface-integral and its Application to the Expansion of the Potential of Ellipsoids in Series: Dr. Hobson,

SOCIETY OF ARTS, at 4.30.—Upper Burma under British Rule: H. Thirkell White.

INSTITUTION OF ELECTRICAL ENGINEERSf at 8.—Experimental Researches on Alternate-Current Transformers: Prof. J. A. Fleming, F.R.S. (Discussion.)

LONDON INSTITUTION, at 6.—Electric Lighting (1) Generation of Electric Currents: Prof. Silvanus Thompson, F.R.S.

FRIDAY, JANUARY 13.

PHYSICAL SOCIETY, at 5.—Upon Science Teaching: F. W. Sanderson.
SOCIETY OF ARTS, at 8.—The Development and Transmission of Power from Central Stations: Prof. W. Cawthorne Unwin, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 7.30.—Description of the Design and Construction of a Roadway Bridge over the River Cam: Edwin Hulme.

AMATEUR SCIENTIFIC SOCIETY, at 8.—Geology in 1892: A. M. Davies.—Recent Developments in the Metallurgy of Gold: T. K. Rose.

SATURDAY, JANUARY 14.

ROYAL BOTANIC SOCIETY, at 3.45.

SUNDAY, JANUARY 15.

SUNDAY LECTURE SOCIETY, at 4.—Some Invasions of India and their Results" (with Oxyhydrogen Lantern Illustrations): R. W. Frazer.

MONDAY, JANUARY 16.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30 (at the University of London, Burlington Gardens, W.)—Journeys in Sarawak, Borneo (Illustrated by the Oxy-hydrogen Lantern): Charles Hose.
VICTORIA INSTITUTE, at 8.—Why the Ocean is Salt: Prof. Hull, F.R.S.
LONDON INSTITUTION, at 5.—The Spanish Armada (Illustrated): F. L. S. Horsburgh.

TUESDAY, JANUARY 17.

ZOOLOGICAL SOCIETY, at 8.30.—A Proposed Classification of the Hesperiidæ, with a Revision of the Genera: E. Y. Watson.—Descriptions of New Species of Dipterous Insects of the Family Syrphidæ in the Collection of the British Museum, with Notes on the Species described by the late Francis Walker: E. E. Austen.—On Two New Species of Copepoda from Zanzibar: Gilbert C. Bourne.

MINERALOGICAL SOCIETY, at 8.—On a Discovery of Oriental Ruby and Margarite in the Province of Westland, New Zealand: Prof. G. H. F. Ulrich.—On the Isomorphism of the Red Silvers: H. A. Miers.—On the Occurrence of Baddeleyite (Native Zirconia) in Brazil: L. Fletcher, F.R.S.

ROYAL STATISTICAL SOCIETY, at 7.45.—The Reorganization of our Labour Department: David F. Schloss.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Gas Power for Electric Lighting: J. Emerson Dowson. (Discussion.)—Reception by the President and Council.

ROYAL INSTITUTION, at 3.—The Functions of the Cerebellum, and the Elementary Principles of Psycho-Physiology: Prof. Victor Horsley F.R.S.

WEDNESDAY, JANUARY 18.

ROYAL METEOROLOGICAL SOCIETY, at 7.15.—Annual Meeting.—The High Altitudes of Colorado and their Climates: Dr. C. Theodore Williams.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Annual Meeting.—Presidential Address: Dr. R. Braithwaite.

ENTOMOLOGICAL SOCIETY, at 7.—Election of Council and Officers for 1893: Report of the Council, and Address by the President, F. D. Godman, F.R.S.

THURSDAY, JANUARY 19.

ROYAL SOCIETY, at 4.30.—The Bakerian Lecture: The Rate of Explosion in Gases: Prof. H. B. Dixon, F.R.S.

LINNEAN SOCIETY, at 8.—The Plants of Malanji, collected by Mr. A. Whyte, and described by Messrs. Britten, Baker, and Rendle: W. Carruthers, F.R.S.—Report on the District traversed by the Anglo-French Sierra Leone Boundary Commission: G. F. Scott Elliot.

CHEMICAL SOCIETY, at 8.—The Determination of the Thermal Expansion of Liquids: Prof. T. E. Thorpe, F.R.S.—The Thermal Expansion and Specific Volumes of Certan Paraffins and Paraffin Derivatives: Prof. Thorpe, F.R.S., and Lionel M. Jones.—The Hydrocarbons formed by Decomposition of the Citrine Dihydrochlorides: W. A. Tilden, F.R.S., and Sidney Williamson.—Camphorsulphonic Derivatives: F. S. Kipping and W. J. Pope.—Note on the Decaphanes formed from Terpenes and Camphor: Henry E. Armstrong.

INSTITUTION OF CIVIL ENGINEERS, at 2.30.—Students' Visit to the Works of Messrs. Maudslay, Sons, and Field, Westminster Bridge Road, S.E.

ROYAL INSTITUTION, at 3.—Tennyson: Rev. Canon Ainger.

LONDON INSTITUTION, at 6.—Electric Lighting (2) Electric Lamps: Prof. Silvanus Thompson, F.R.S.

FRIDAY, JANUARY 20.

ROYAL INSTITUTION, at 9.—Liquid Atmospheric Air: Prof. Dewar, F.R.S.

SATURDAY, JANUARY 21.

ROYAL INSTITUTION, at 3.—Expression and Design in Music (with Musical Illustrations): Prof. C. Hubert H. Parry.

CONTENTS.

THURSDAY, JANUARY 19, 1893.

HEREDITY.

Das Keimplasma. Eine Theorie der Vererbung. By August Weismann, Professor in Freiburg i. B. (Jena: Gustav Fischer, 1892.)

IN the substantial volume whose title stands at the head of this article Prof. Weismann has gathered together the results of the essays and researches which he has given to the world during the last eleven years, and he now presents us with a theory of heredity, for which his previous writings have been but preparatory.

Those who have followed the German philosopher since the appearance of "Die Dauer des Lebens" in 1882 have traversed a wide territory. They have seen many theories and hypotheses come into view and attain a certain degree of definiteness. Some of these are now lost to sight, others have changed their outline and altered the relative proportion of their parts, but, whatever was the standpoint, the central feature of Prof. Weismann's theory of heredity—the continuity of the germ-plasma—remained unchanged.

The work before us consists of an introduction, partly historical, and of four books, in which the theory and its application to various biological problems are set forth in the fullest possible manner, and in language for the most part free of technical phrases, so that a non-scientific reader can easily follow the argument. At the close of the volume are a summary of the four books and an index. The latter is a novelty in a German book of this kind, for which we cannot be too grateful to its compiler, Fräulein Diestel.

The title of the work strikes the key-note of Prof. Weismann's theory. Heredity, according to his view, is brought about by the transference from one generation to another of a substance with a definite and very complex constitution, the germ-plasma. This substance is the material basis of heredity; and it is supposed that a part of it in each reproductive cell is not used up in the construction of the offspring, but is transmitted unchanged to form part of the reproductive cells of the following generation. As the author points out, his theory might be termed "Blastogenesis," or the origin from the germ-plasma, as opposed to Darwin's Pangenesis, or the origin from all parts.

This germ-plasma is necessarily a most complicated substance; it cannot arise anew, but can grow and increase. Its ultimate constituents, according to the latest view of the Freiburg professor, are certain units termed biophores, which possess the properties of assimilation, growth, and multiplication by means of fission. So long as the organic world consisted of biophores living either singly or united in colonies, heredity and multiplication with subsequent growth were one, since each division resulted in two similar halves, which by growth gave rise to organisms exactly like the parent.

But, when the principle of the division of labour made itself felt, the biophores became differentiated, and simple division no longer sufficed to give rise to two similar organisms, each exactly like their parent. A special mechanism was needed to bring about heredity, and according to our author this was found in the nucleus. This differentiated part of the cell was originally a collection of reserve biophores. After the division of the nucleus the biophores in each half multiplied, and so replaced those which had separated from them, and thus rendered possible the completion of the new organism. The structure of the nucleus became still more complicated when amphimixis, the mingling of the hereditary substance of two individuals, made its appearance. Amongst multicellular organisms, with their endless variety of cells, the same mechanism exists, but in a still more complicated form. Sexual reproduction has arisen; that is, the "Anlagen" for the whole organism are collected into a single reproductive cell, two such cells come together, and the resulting fertilized egg cell contains the hereditary substance of two individuals.

According to Prof. Weismann's present view, this hereditary substance or germ-plasma consists ultimately of biophores. These units are built up in a definite order and arrangement into units of the second degree, which are termed "cell determinants," or simply "determinants." Every cell of a multicellular organism is dominated in its histological character, and in the rhythm and nature of its division by one of the determinants. Each cell has not, however, a corresponding determinant in the germ-plasma, but cells of the same sort, as, for instance, blood corpuscles, may be represented in the hereditary substance by the same determinant. In the germ-plasma of any species there must be as many determinants as there are variable cells or cell groups in the organism. The determinants are arranged in a definite order in units of the third degree termed "ids."

These ids, which will be familiar to readers of Prof. Weismann's latest essay, that on Amphimixis, are again built up into idants, and these last probably correspond with the chromatosomes, or nuclear rods of the nucleus. Thus the germ-plasma consists of idants; the idants are composed of ids; the ids are built up in a definite manner of determinants; and the determinants are formed of the final units, the biophores.

It is assumed that the biophores can pass out of the nucleus and divide and multiply in the surrounding cell protoplasm. Amphimixis brings about the mingling of a certain number of biophores from one parent with a similar number from the other, and the organism whose body is dominated by this mixed assemblage of biophores partakes of the nature of both parents.

In the reproductive cells of the higher plants and animals the nucleus must contain not only those determinants which dominate the structure, rate of division, &c., &c., of the cell itself, but also those which will dominate the various cells and systems of cells which will eventually arise from the reproductive cell; and furthermore these must be definitely arranged in a given order, so that they may not be all called into activity at once, but may become functional successively, in accord with the origin of the cells they control.

It is not possible within the limits of a short article to describe the many ingenious applications of his theory, by means of which Prof. Weismann attempts to explain such phenomena as the Regeneration of lost parts, Reversion, Budding, Alternation of Generations, &c.: all

these are brought into line, and are shown to be capable of an explanation in the theory of germ plasma. Dimorphism and seasonal dimorphism are explained by the assumed existence of double determinants, one corresponding with each form, and remaining inactive during the life-time of the organism controlled by the other.

Such changes as affect the cell body cannot be transmitted according to this view, since alterations in the cell have no effect upon the biophore which in the next generation will dominate the corresponding cell of the offspring. But, since variation must be ultimately dependent on external circumstances, influences such as climate, change of food, &c., are considered to have in the course of time some effect upon the determinants, and a corresponding change in the organism results. In this lies one of the chief differences between the germ-plasma theory of Prof. Weismann and the Pangenesis of Darwin. They both give a possible explanation of heredity; but in the latter case the gemmules, coming from every cell of the body, afford an explanation of the transmission of acquired somatic changes; in the former case the biophores, arising only from other biophores, would be uninfluenced by any such change. A. E. S.

THE BASIS OF ALGEBRA.

The Algebra of Co-planar Vectors and Trigonometry. By R. Baldwin Hayward, M.A., F.R.S., Senior Mathematical Master in Harrow School, formerly Fellow of St. John's College, Cambridge. (London: Macmillan & Co., 1892.)

THIS work is constructed on the methods of the school of mathematicians who derived their inspiration from the teaching of De Morgan, a school which is represented by many of the most influential of our recent writers on mathematical subjects. It is intended to occupy the place of the "Trigonometry and Double Algebra," published in 1849 and now a long time out of print, at the same time incorporating such improvements in elementary treatment as have been evolved out of half a century's discussion of the foundations of Algebra. Those who are acquainted with Mr. Hayward's other writings, such as his "Elements of Solid Geometry," will expect a fresh and interesting treatment of his subject; and they will not be disappointed. On turning over the pages we constantly come across elegant touches and happy turns of expression, and historical appreciations—the stuff which constitutes the basis of literary excellence in mathematical writings.

The treatise is primarily concerned with the logical exposition and illustration of the principles on which Algebraic Analysis, including Analytical Trigonometry, is founded. The utility of this subject in its practical applications renders it a necessary part of even an elementary course of reading; while a very refined treatment of it may lead so far into the notions of the Theory of Functions and algebraic continuity in general, as to somewhat overlay the really simple matters with which it is concerned. In this country the tendency in elementary books has, until recently, been rather to take the fundamental formulæ on credit, and to make the subject consist of the development of their analytical and practical consequences. The philosophical principles which bind them into an organic whole have retained so much the aspect of *à posteriori* developments, that there is some temptation to proceed in the view that Mathematical Analysis is an inductive science like Natural Philosophy; that it is one part of the science to invent and verify the formulæ, while the logical calculus which gives them precision and limitation is quite another department. The great majority of readers of the elements of Algebra have no time for an exhaustive discussion of the nature of continuous quantity and all the types of singularity to which it is liable; while on the other hand complete neglect of the logical basis of Analysis deprives it both of a main source of its interest, and of a large part of its value as an intellectual training. Hence arises the importance, even in presence of the complete theory with which a specialist must be acquainted, of the simplification and improvement of methods of exact treatment within the domain of elementary ideas.

The author's method starts off from an *à priori* discussion of the Algebra of Co-planar Vectors, which leads him to the two modes of specification of a vector, as a power of the fundamental vector, and as a sum of components. The identification of these two expressions leads to the analytical definitions of the *sine* and *cosine*, and by way of certain theorems in algebraic limits [whose explicit enunciation is by the way not essential] to the orderly development of the subject. The theorems concerning series which involve the complex variable are strikingly illustrated by corresponding vector chains, and geometrical interpretations are throughout very copious. The treatment is here so full and many-sided, that it would form an interesting occupation for the reader to take up the other aspect of the matter, and try to pick out the simplest and briefest analytical foundation on which the formulæ required for practical applications may be built.

The remarkable formula of p. 115, $(4{\cdot}810475\ldots)^{\iota} = \iota$, if removed from the context in which it is set, might be propounded as a puzzle in interpretation. The author introduces us straight off to an expression with a complex index, and proceeds to ascertain whether any meaning can be assigned to it, which will allow the inclusion of such expressions in the algebraic calculus. The geometrical method gives him very neatly and definitely an expression for the values of A^B, where A and B are both complex, by means of the vector ribs of a fan of equiangular spiral form. But when the conception of logometers (analytical logarithms) to a vector base comes up for interpretation, the answer proves to be some one of an infinito-infinite series of vectors related to one another in a manner so complicated as to elude definite grasp; and we have arrived at a case in which the inclusion of the function in our calculus would, in the absence of special machinery of representation like a Riemann's surface, be best avoided.

The origin of all difficulty in the treatment of complex algebra lies in fact in the multiplicity of values of the functions with which it deals. If each function can be defined as spread out in a multiple sheet so as to be single-valued at each point on each leaf of the sheet, a great part of the trouble disappears. We can then if we

please make explicit use of the Principle of the Permanence of Equivalent Forms, which, after having been expounded at length and defended by Peacock (appendix to "Algebra"), has been summarily rejected as misleading and unmeaning by many recent authors. To the formal reintroduction of this principle Mr. Hayward's language exhibits a tendency to return. Outside the domain of elementary Algebra, its strict employment in the prolongation of an analytical function into a new region is indeed of common occurrence in Analysis; while its tentative application in unrestricted form, as an instrument of suggestion and discovery in the Theory of Operations, is fundamental. To the effort to widen the limits of interpretation in connexion with it, has been due most of the advances in Analysis.

It is a fundamental question in mathematical logic how far, after having carried the stream of our analysis through regions of uninterpreted symbols, and having at length arrived at a stage in which these symbols have disappeared, we are entitled to claim this procedure to be demonstrative. It is of course of the very essence of Algebra that the intermediate steps of its analysis remain uninterpreted; though in the Algebra of real quantities we have a tacit assurance that an interpretation can be supplied if necessary. Why then was there an objection to a similar procedure in the Algebra of complex quantities; and what is the source of the timidity and doubt which characterized the use of complex analysis before its geometrical interpretation was developed? Simply that complex quantities turned out to be multiple-valued, and that the selection of the proper value under given circumstances had to be settled by tracing the continuity of the quantities in a way that was to the mind practically impossible until a visual geometric representation was discovered. The Argand diagram is not essential to the logic of the matter; it rather makes Analysis possible by bringing its scope within our grasp. It simply forms a more extensive and systematic example of the method which has been in use since the time of Descartes for studying functions and approximating to their roots, by aid of their graphical representation.

The Principle of Permanence of Equivalent Forms thus lies at the very root of Algebra, but it is rendered ineffective by indeterminateness of interpretation. Its strict use, when most needed, is subject also to another hitch. It requires that the forms be expressed in exact terms; an infinite series must be expressed in the sum of n terms together with a residue R. These residues must be retained throughout the analysis until we arrive at a point where interpretation comes in; and it must then be settled how far they can be neglected in the circumstances of the actual interpretation. In the language of Mr. Hayward, it cannot be asserted about series that are not absolutely convergent, that the fundamental laws of Algebra hold without limitation.

It is perhaps a question how far the idea, thus restricted and safeguarded, is worth being expressly retained as a working principle of ordinary Algebra. In subjects like the Calculus of Operations and Finite Differences, which are still in an unsytematized stage, it cannot be dispensed with; and the extent to which its use is boldly pushed, by De Morgan and Boole, even to the discussion in an operational manner of divergent series without their residues, contrasts with the more exact processes of recent Analysis. How far this boldness arises from the profound logical studies of these writers, and their appreciation of the imperfect character of inference at the best, may be a subject open to discussion.

In connexion with the doctrine of convergence of series, the author gives a very clear account, from Sir G. Stokes, of how it is that, on approaching certain critical points, the convergence may gradually fall off and finally disappear. The illustrations employed are algebraic series of an exceptional character; and the whole circumstances may possibly suggest to the uninitiated that it is a phenomenon of exceptional rarity. The most natural context is, of course, in connexion with the wonderful and far-reaching theory initiated by Fourier, by means of which functions arbitrarily discontinuous are expressed by seemingly continuous series. In that connexion, the necessity of explanation is so obvious that it is interesting to examine the previous attempts at elucidation. Thus De Morgan, in 1839, is able to conclude (" Diff. and Int. Calc.," pp. 233, 239) that such discontinuity cannot occur in series proceeding by powers of a real variable; that in other cases it occurs only through the series becoming divergent at the point of discontinuity. It is, however, an important question how far it would be allowable to avoid burdening an elementary exposition by complete precautions against the existence of anomalies like this, which would hardly have originally occurred to any one in that early stage.

The book ends with a wider survey, including a clear and interesting account of Cauchy's theory of the radical points of a rational function. The graphs of the cubic $z^3 + az$, which are given as an illustration, would also form excellent and rapid examples of the Rankine-Maxwell method of graphical addition, applied to the separate graphs of z^3 and az.

J. L.

FOSSIL PLANTS AS TESTS OF CLIMATE.

Fossil Plants as Tests of Climate, being the Sedgwick Prize Essay for the Year 1892. By A. C. Seward, M.A., F.G.S., Lecturer in Botany in the University of Cambridge. (London: C. J. Clay and Sons, Cambridge University Press, 1892.)

THIS admirable essay is really a digest of the opinions of the principal writers on fossil plants, so far as they throw light on geological climates, and a critical *résumé* of the subject up to date. It should be read by all who prefer to deduce the relative temperatures of various latitudes in the past from such solid data as assemblages of ferns, cycads, and conifers, the ancestors of living genera and species, rather than from utterly extinct belemnites, ammonites, and saurians, of whose habits little can ever be known, and which might have drifted far out of their temperature zones by warm and cold sea-currents.

Perhaps if any criticism can be made, it is that too little has been said by the author as to what is known of the Mesozoic floras, which, if scanty, are extremely interesting. In fact only the widely-separated Palæozoic and Cenozoic floras are fully dealt with. Owing to the magnitude, difficulty, and freshness

of the problems presented by the former, they have received the larger share of attention and have ever attracted some of the most acute and philosophic of scientific workers. But while the researches of such investigators as Williamson and Renault into the actual structures and affinities of the carboniferous plants have been rewarded with the most brilliant successes, attempts to speculate and theorize have only been productive of barren controversy. All inferences as to the temperatures in which they flourished have merely been inductions from unknown data: their affinities with existing plants are so remote that they can tell us of little beyond moist climates and spongy, marshy soils, liable to inundation, with possibly an atmosphere more highly charged with carbonic acid than at present. But that neither the flora nor identical conditions were uniformly present over the whole land during the deposition of the carboniferous, becomes every year more apparent; and perhaps few would now maintain that fossil floras met with in widely-different latitudes must necessarily be contemporary because similar, or reject as impossible the correlation of the Glossopteris floras of the southern hemisphere simply because they are so dissimilar.

Tertiary floras, however, have to be approached from almost totally different standpoints, for here minute investigations into vegetable structure can only exceptionally lead to important results. On the other hand it may be possible to predicate the climate that any group among them would have required, with almost perfect accuracy. Allowing that even most closely-allied species may have had different habits, enough remain that are practically identical with living species. These not only prove to us that in every land in our hemisphere the temperatures remained warmer throughout the Tertiary period than at present, but also that the temperatures were far from equable during Eocene time. Thus it is impossible to hesitate as to the evidence of the flora in the lower stages of our Eocene, which exhibits an abundance of planes, poplars, and alders and an absence of all approach to sub-tropical essences; nor as to that of the London Clay, with its tropical nipas, sabals, and a host of others almost indistinguishable from species existing at the present day. There is scarcely need of the corroborative evidence of the Mollusca as to cooler seas in the Thanets, nor of tropical conditions in the large turtles, crocodiles, snakes, and nautili of Sheppey. In fact, the temperature of the spots occupied by Reading, Bournemouth, or Mull at a particular stage of the Eocene could be predicated from the fossil floras almost as accurately as from living plants. If the same cannot be said of the Arctic regions it is simply that the specimens brought home are, perhaps from the exigences of travel and inexperience of the collectors, for the most part so imperfectly preserved and fragmentary, that few of the determinations can carry the smallest weight. It may suit quidnuncs to accept indeterminable fragments as evidence of the growth of palms and cycads in the Greenland Eocene—it is time the Miocene age of these beds was relegated to the limbo of Coal-measure palms and yuccas—and to become excited over the presence of a sub-tropical flora within the Arctic circle; but as a fact it is doubtful whether anything has been discovered there which might not have grown in our own temperature, if slightly modified, a state of things which it is conceivable the damming back of the Arctic seas by the land connection which then existed between Europe and America, aided by an active Gulf Stream, might have brought about. When we come to the Miocene, worked out as that of Switzerland was by Heer, or still more the Quaternary, with such data as those laboriously amassed by Clement Reid, the inferences as to climate are still more irresistible.

As to evidence of the age of rocks, plants are less trustworthy, because they have neither been so perfectly studied nor are their zones as yet at all properly defined. All we can say is that certain assemblages are found in association at the beginning of the Tertiary, and that changing temperatures have since compelled them not to disperse, but to migrate far and wide. Fewer probably of the species are extinct than is generally supposed, and the primitive associations have held together perhaps to the present day, with many gaps from extinction and desertion and a large infusion of recruits through the ordinary causes of evolution, stimulated by the increase in browsing mammalia. Whether, on the other hand, the marine deposit zones are really entitled to the weight attached to them as evidences of age, except locally, is not so clear. They are usually the littoral deposits of a limited area, where some changes of level or current have apparently suddenly driven out the fauna and introduced new colonies more adapted to the changed conditions. If we could follow the subsequent wanderings of these assemblages under the sea our faith in their sudden extinction and consequently in their chronological value might be greatly modified. At all events, many of the less conspicuous groups of mollusca, when critically examined, prove to have surprisingly near relatives in distant seas at much later periods, and even at the present day.

J. STARKIE GARDNER.

OUR BOOK SHELF.

Pioneers of Science. By Oliver Lodge, F.R.S. (London and New York: Macmillan and Co., 1893.)

THIS book consists of eighteen lectures on the history and progress of astronomy, which were delivered by Dr. Lodge in 1887. "The lectures having been found interesting," he thought it "*natural* to write them out in full and publish," and, although this can scarcely be considered a sufficient excuse, the intrinsic merits of the work are abundant justification for its existence. In Part I., "From Dusk to Daylight," the progress of astronomy from Copernicus to Newton is traced in a series of vivid pictures of Copernicus, Tycho Brahe, Kepler, Galileo, Descartes, and Newton; while Part II., "A Couple of Centuries' Progress," brings the history of gravitational astronomy from Newton down to the present time. In these latter lectures Roemer and Bradley are associated with the velocity of light and aberration; Legrange and Laplace with the solar system and the nebular hypothesis; Herschel with the motion of "fixed" stars; Bessel with the distances of stars; Adams and Leverrier with the discovery of Neptune; and Lord Kelvin and George H. Darwin with tides. Dr. Lodge has been able, by judiciously combining clear statements of scientific facts and laws with interesting personal details, to give his lectures all the charm of a romance. The book is an admirable introduction to the study of astronomy, and no better gift for a beginner could well be chosen; while to those to whom many of

its details are already familiar, the picturesque clearness with which they are presented will make their knowledge more real and more complete. The standard of excellence maintained in the lectures makes distinction difficult and invidious, or we would distinguish the lectures on Newton and those on tides as models of what such popular scientific expositions should be. The book is copiously, and, on the whole, well illustrated, but some of the illustrations—notably those of clusters and nebulæ—are very familiar and somewhat out of date. A curious mistake occurs on page 201, where a well-known drawing of a comet appears as an "old drawing of the Andromeda nebula." The illustration on page 326, showing the paths of Uranus and Neptune and their relative positions from 1781 to 1840, and professing "to illustrate the *direction* of their *mutual* perturbing forces," is partly misleading; but in introducing this Dr. Lodge has erred in good company, for the diagram, originally due to Dr. Houghton, appears in many of our recent astronomical text-books. A. T.

Electric Lighting and Power Distribution. Part I. By W. Perren Maycock, M.I.E.E. (London: Whittaker and Co., 1892.)

THIS cheap and useful little text-book has been written for the author's junior students, as he is of opinion that no trustworthy elementary work on the subject is to be obtained. The scope of the work has been limited to the syllabus of the ordinary grade examination of the City and Guilds of London Institute. We find, however, much information on subjects not usually found in other manuals. The book is freely illustrated, and the descriptions are clear.

It is very important for the junior student to understand clearly what is meant by a line of force, and to grasp the fact that lines of force are only *assumed* to exist, because, by such an assumption it is possible to explain many, otherwise inexplicable, phenomena. On page 47 we find the following statement:—"The power which any magnet possesses, of picking up pieces of iron, and of acting upon another magnet, depends upon the existence of lines of magnetic force." This quotation is vague; a junior student might easily imagine that the lines of force really existed, whereas they are purely assumptions, to elucidate the phenomena of magnetic attraction. The illustrations of simple bar magnets, solenoids, and electro-magnets, in which the lines of force are delineated, should have the assumed directions of the lines of force clearly shown by arrow-heads. This might be done with advantage in Figs. 17 to 20.

Chapter IV. deals with induction of currents, electromagnetic induction, Faraday's Law, and concludes with a clear description of magneto-motive force, magnetic resistance, magnetizing force, induction and permeability. These latter are very difficult for a junior student to understand thoroughly, and the author should have devoted more space to the discussion of these important points in dynamo construction. One particularly good feature in this text-book is the large number of questions arranged at the end of each chapter. These are well suited to test the knowledge of a student. Chapter V. deals generally with electrical testing, measuring instruments used in installations, and meters for measuring the current, such as Teague's, Elihu Thomson's, and the Wright-Ferrauti. Chapter VI. concludes the book, describing the principle of the dynamo, different types of machines, and the construction of the various parts.

Taken as a whole this book attempts too much. The matter described has suffered considerably by condensation, a serious thing where junior students are concerned. Most of the illustrations are good; some are indistinct, and Fig. 98 is decidedly wrong, showing the brushes set for one direction of rotation, and the arrow indicating the reverse.

On the other hand the sequence of matter is good, and a student should learn much from the work. The author takes great pains to describe clearly the many units involved, particularly the applications of Ohm's law. The book would last much longer in the hands of the average student if the present paper binding were replaced by something stronger.

The Naturalist on the River Amazons. By Henry Walter Bates, F.R.S. With a memoir of the author by Edward Clodd. Reprint of the Unabridged Edition. With Map and Numerous Illustrations. (London: John Murray, 1892.)

THIS work is so well known, and has long held so high a place among scientific books of travel, that it is unnecessary to do more than note the appearance of a new edition. It is clearly printed on good paper, and the illustrations are well reproduced. The introductory memoir by Mr. Clodd is a most welcome record of the main facts of Mr. Bates's career. The materials for this interesting sketch were enriched by letters placed at the author's disposal by Sir Joseph Hooker and Mr. Francis Darwin. An excellent portrait of Mr. Bates is included in the volume.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Proposed Handbook of the British Marine Fauna.

SUCH a handbook as Prof. Herdman suggests is so much wanted that many naturalists must from time to time have felt tempted to essay it. But the difficulties are very formidable. Prof. Herdman seems to contemplate the preparation of such a work mainly as a labour of compilation. But the groups where compilation would nearly suffice are just those where the handbook is least required. On the other hand, such a group as the Amphipoda, in spite of Canon Norman and Mr. Stebbing's many papers, is still in great need of revision; it was only the other day that Canon Norman opened our eyes to our rich fauna of Mysidæ, before which time no search among published records would have told us anything worth the having; we are in just the same position as to our British Cumacea, until Canon Norman again reveals the treasures of his cabinet; our Pycnogrns are almost as little known. In every one of these groups, and in many others like them, the preparation of a hand-list would need the experience of a specialist, just as much as the Tunicata would require Prof. Herdman's own special knowledge. The area to be embraced is another difficulty. Prof. Herdman proposes to take the British area as defined by "Canon Norman's" B.A. Committee in 1887, on which he himself served. But the committee's report was repudiated by Canon Norman himself, who afterwards suggested a wider "British area," whose boundaries I fancied had since been recognized as more suitable by everybody. However the British area be defined, there will long remain a difficulty in the numerous forms not yet recorded from within it, but which are likely, or certain, to turn up when sought for. Such things as the parasitic and other Crustacea described of late years by Giard and his pupils from Wimereux form a case in point. I am inclined to think that to make in the first instance a hand-list of the whole fauna of the North Atlantic basin would be not a bit more difficult, but in some respects easier, than to restrict the list to the British area alone. That it would be incomparably more useful is certain. It would make a book not more than three times (perhaps little more than twice) as big as Carus's "Fauna Mediterranea." And it would be a very important step towards that new *systema naturæ* of which the Germans are already beginning to talk, and which it is high time were begun.

But Prof. Herdman both asks discussion of his plan, and also invites criticism on his execution of it. Take his very first illustrative genus, which he tabulates as follows:—

ANTENNULARIA.—Stems simple or branched; pinnæ verticillate; nematophores along the stems; gonothecæ axillary, unilateral.

A. antennina, L., stems clustered, usually simple; hydrothecæ separated by 2 joints. 6 to 9 in. high. Gen. distr. deep w.

A. ramosa, Lamk., stems single, usually branched; hydrothecæ separated by 1 joint only. 6 to 9 in. high. Gen. distr. deep w.

Now there are *no* nematophores along the stem, but only on the pinnæ; *A. ramosa* may sometimes grow up unbranched, but I for one never saw it so, and *A. antennina* is always simple, save by the rarest individual abnormality; the dimensions are quite inaccurate, for we have *A. antennina* here of all sizes up to 24 inches high. The distribution given is too vague. In the report of the B.A. Committee, which Prof. Herdman goes by, deep water is defined as that below 100 fathoms; but these two are not deep-water species, either in that or any other common use of the phrase. The authorities are very loosely given. *A. antennina*, L., should be (L.), and if the bracketed authority, *i.e.* the original user of the specific name, is to be the one quoted, then for *A. ramosa*, I think Lamk. should give place to (Lamx.). And why is the authority for the genus left out altogether?

Moreover, even if these definitions were verbally accurate so far as they go, they would only suffice to exclude one another, with no reference to other non-British species. They are rather definitions of groups of species or sub-genera, than of these two particular forms. It would not matter very much, perhaps, in this case, where other species are not likely to turn up upon our coasts; but such definitions, drawn with reference only to known British forms, would soon lead to hopeless confusion in the case of less-known groups. D'ARCY W. THOMPSON.

Dundee, January 11.

On an Abnormality in the Veins of the Rabbit.

AMONGST a number of rabbits dissected in my laboratory last term, one specimen exhibited a peculiarity in the venous system which is especially interesting in connection with Hochstetter's and Macalister's accounts of the development of the veins. Unfortunately the specimen had been too far dissected before the abnormality was noticed to follow out every detail.

The blood from the hinder extremities, urinogenital organs, and abdominal walls, passed into a large vessel having the position and relations of a postcaval posteriorly. Instead, however, of passing through the dorsal border of the liver to penetrate the diaphragm, it was seen at the anterior part of the abdomen to correspond to the azygos, receiving the superior intercostal veins, and opening into the right precaval. This vessel evidently, then, corresponded to the persistent right posterior cardinal. The portal system was apparently normal, and the hepatic veins opened into a postcaval, which extended through the diaphragm to the heart in the usual manner.

Thus the independently-formed section of the postcaval (*Leberabschnitt*) had taken on no connection with the part developed from the cardinals (*Urnierenabschnitt*), but had remained as a separate vein, bringing back the blood from the alimentary organs (and ? diaphragm) only.

I have not thought it necessary to do more than mention these facts, as the whole question has recently been fully discussed by Dr. A. Robinson ("Abnormalities of the Venous System and their relation to the Development of Veins," "Studies in Anatomy from the Anatomical Department of the Owens College," vol. i. p. 197, Manchester, 1891). The above case, however, supports the view that the renal veins are direct tributaries of the right cardinal, and not of the postcaval; while the reverse conclusion is derived from Dr. Robinson's observations. W. N. PARKER.

University College, Cardiff, January 14.

Difficulties of Pliocene Geology.

YOU were good enough to print a letter from me a week or two ago, in which I called attention to some of the difficulties in explaining the distribution of the so-called Pliocene beds. I should like to prosecute the subject a little further.

The geographical distribution of the mastodon is assuredly one of the greatest paradoxes in natural science.

As is well known, it occurs both in North and South America, and on both sides of the Rocky Mountains and the Andes. It has not occurred, however, so far as I know, north of the great lakes in the east, nor of Oregon in the west, nor has it ever been reported from Alaska, where mammoth remains are so abundant. I do not know any evidence that it has been found anywhere in Asia, north of the Himalayas, neither in China, nor Manchuria, nor Mongolia, nor Turkestan, nor in Siberia; nor has it occurred in European Russia, except close to the Black Sea, nor in Poland, nor in Scandinavia, nor in North Germany.

In the Old World its zone of distribution extended from India to the Pyrenees, including the Mediterranean borders, the valleys of the Danube, and the Middle Rhine, Eastern England, and perhaps Iceland, whence some teeth are said to have been sent to the royal collection at Copenhagen. This distribution of a very highly specialized beast is certainly most extraordinary. Granted that the mastodons of Western Europe and those of America are slightly different, the difference is so slight that, as Falconer says, Cuvier treated them as the same species, and they cannot have been very long isolated. Yet how are we to explain the facts, and do justice to the widespread view that the ocean areas are very old?

It seems to me as clear as anything can be that when the mastodon was distributed over Western Europe and America, there must have been a land communication between the two areas, and I cannot see how, with the facts before us, we can escape the conclusion that this connection must have been across either the Atlantic or the Pacific, not in high but in low latitudes, perhaps across both.

The mastodon is not the only animal which points the same lesson. The machairodus, a very highly specialized feline, has been found both in the Old and the New World, but did not inhabit the great palæarctic province of Europasia, east of the Rhine, nor America north of the great lakes. The American jaguar, a mere variety of the Old World leopard, is another animal with the same abnormal distribution, so are the American and the Old World tapirs.

Now this connection between the Old and the New World cannot, so far as we can judge, have been in high latitudes, for the forms in question have not occurred in high latitudes. If the connection had been across the Northern Pacific, we should have had some remains of these animals in Japan, where more than one fossil elephant has occurred; or in the Sandwich islands, which are, to all appearances, a very old land-surface.

The connection must, therefore, if it was across the Pacific, have been across its more equatorial part. It seems similarly to follow from the absence of these animals in the high latitudes of America and Europe, save the doubtful case of Iceland, that in the case of the Atlantic also the land-bridge must have been further south, and perhaps where the Atlantic islands still remain. One more inference. If there was a penannular or circular belt of land about the earth in the tropical or subtropical zone over which these beasts could travel, it would possibly account for the tertiary climate of high latitudes having been a warm one, as we know it was. A zone of land in the tropics would act as a furnace, whose heat would be widely distributed by the ocean currents in contact with it.

The views here urged, it will be said, are like those of the advocates of a Miocene Atlantis. They are in essence very different, and meant to explain a very different phenomenon, namely the aberrant and abnormal distribution of the mastodon and its companions. The mention of the Miocene Atlantis, however, suggests another and more critical difficulty in explaining the Pliocene beds, but this must be postponed to another letter. HENRY H. HOWORTH.

The Athenæum Club, January 13.

Earthquake Shocks.

A SERIES of slight earthquake shocks have lately occurred in this district, viz. January 3, 2.15 p.m. at Severn Junction (E.J.L.) January 4, 11 a.m., Itton Court, Chepstow (a heavy plant in a greenhouse was seen to move four times by Mr. J. Curr and the Rev. N. S. Barthropp); January 5, between 2 and p.m., and again on the 6th (a little earlier), Llanthony Monastery (a rumbling noise on the Black Mountains near the monastery Mr. P. E. Hill); January 14, 6.55 p.m., a shock lasting mo r than a second, Bigswear House, Coleford, Mr. J. V. Newbery (Mr. Newbery has had experience of earthquakes, from a long residence in Japan). E. J. LOWE.

Shirenewton Hall, Chepstow.

The Weather of Summer.

I REGRET to find that, in making a quotation at the end of my letter last week (p. 246), I erred in supposing Mr. Symons to be the writer. I beg to apologize for the slip. A. B. M.

ON THE ORIGIN OF THE ELECTRIC NERVES IN THE TORPEDO, GYMNOTUS, MORMYRUS AND MALAPTERURUS.

THE subject of this communication may seem remote and uninteresting, but it will not be difficult to show that questions of the highest importance for physiology, anatomy, and the Darwinian theory are closely related to those touching the structure of the electric organs of certain fishes and the laws of their functions.

The fact that the body of an animal should become a complete electrical apparatus acting at the will of its owner induces us to inquire how this extraordinary result has been attained; that is, to investigate the origin of the electric organs of fishes, and the manner in which the animal throws them into action. We shall see that in pursuing both lines of enquiry we open far-reaching views into regions as yet unknown.

According to the present state of our knowledge there can be no doubt that most of the electric organs hitherto discovered are of muscular origin. It is not my intention to dwell on this transformation of muscular tissue, but it may nevertheless prove interesting to cite an example of the completeness with which such transformation can take place; I refer to the Mormyrus—the so-called pike of the Nile—a fish which has only of late been sufficiently known to possess electric power. A transverse section of the tail of any ordinary fish shows scarcely anything more than the vertebral column, muscles and their tendons, attached to the bones. On the other hand, a transverse section of the tail of Mormyrus (Fig. 1) shows no conspicuous muscles, but in place of them electric tissue filling up the entire space occupied by muscles in ordinary fishes. Of the muscular apparatus there is nothing left except the longitudinal tendons passing outside the electric organs from muscles placed anteriorly. If these tendons were cut across the Mormyrus would be unable to move its tail.

Omitting the complicated arrangement of histological elements in this modified muscular tissue in the different electrical fishes—which could not be sufficiently explained without a large number of illustrations—it may be sufficient to state that a kind of swelling loosens the molecular elements of the muscles and allows them to be settled again in a very regular but quite new form.

The well-known electric eel of America, *Gymnotus electricus*, has only the external shape of an eel, and is in reality a very short fish, carrying very powerful electric organs in a long tail springing from a very short rump. A transverse section of the tail shows that a part of the muscle is changed into electric organs, while another remains unchanged.

In the different kinds of electric skates—Torpedinidæ—the electric organs are developed from muscles, which originally belong to the branchial arches and the arch of the lower jaw.

When we look to the nerve apparatus which enables the fish to throw the electric organs into action by a voluntary impulse, we find in every case wonderfully developed ganglion cells from which the impulse is transmitted directly to the electric batteries. Such a coincidence certainly cannot be the result of mere chance. But beyond the invariable presence of large ganglion cells as the starting points of electric nerve fibres there is very little uniformity in the arrangement of these elements in the different sorts of electrical fishes; on the contrary, there are most remarkable and striking differences not only in the position but also in the number and in the appearance of these nerve centres. It is to be hoped therefore, that some important views regarding the character and functions of ganglion cells in general may be suggested by their study.

In the Torpedo the electric ganglion cells—being in vast numbers—form a bean-shaped mass in the medulla constituting the well-known electric lobe. It represents modified motor centres of the vagus nerve; anteriorly it is covered by the cerebellum, but emerging from beneath that organ, the lobe increases rapidly where the largest electric nerve leaves the medulla. Lower down its size again diminishes, where it gives rise to the fourth electric nerve and terminates quite free in a blunt point on each side. On counting the ganglion cells in a complete series of sections one finds the number to be about 54,000—a number that can be found to nearly correspond with the fibres in the electric nerves that arise from them. A transverse section of the medulla, close to the spot where the roots of the electric nerves are gathering, shows the so-called axis cylinder processes of the cells entering the roots to form the nerves. This is seen in Fig. 2—a photogram taken from nature like all the other illustrations of this paper.

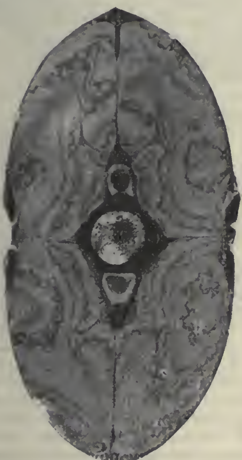


FIG. 1.—Transverse section of the tail of *Mormyrus cyprinoides*.

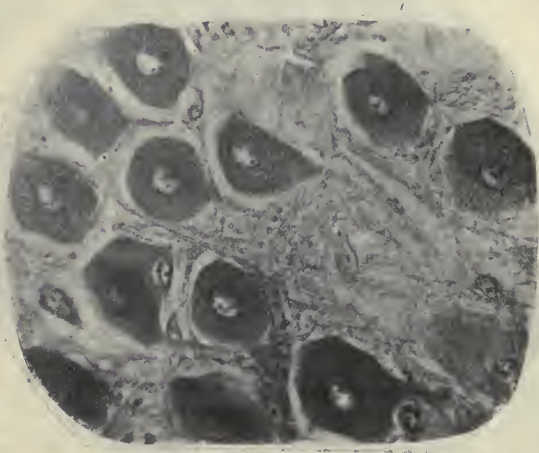


FIG. 2.—Ganglion cells from roots of electric nerves of Torpedo.

Even the first and smallest of the electric nerves shows a great number of nerve fibres collected into bundles which on transverse section appear as if perforated by numerous small openings—each apparent aperture being a nerve fibre. I counted about 8039 fibres in the first electric nerve, in the second or largest about 23,770; in all four nerves about 58,318 fibres. This total exceeds that of the ganglion cells by at least 4000, but the disparity of number is probably to be accounted for by the impossibility of getting an exact total from a series of sections where the cells are very often dragged away by the knife.

The ganglion cells of the Gymnotus, or electric eel, are disposed in a different manner. Behind a short portion at the anterior end of the spinal cord where ordinary cells are found, the grey substance contains large rounded ganglion cells, the most anterior of them forming a semicircle around the central canal of the cord. Since these first cells extend in front of the most anterior electric nerves, a transverse section of this region shows no axis cylinders leaving the grey substance, all being directed downwards to the gathering place of the first electric nerve roots, and therefore must be cut off. If, however, a transverse section be made in the middle portion of the cord the whole grey matter is seen to be packed with electric cells and their axis cylinders are seen passing very straight and undivided to join the electric nerve roots at once. The other processes of the cells are so pale and fine that it is impossible to recognize them sufficiently well in a complete section. Since the electric batteries extend along both sides of the tail to its very end, the electric nerves and their ganglionic centres have a similar extension. The electric cells form a continuous column in the spinal cord, but it is very slender, therefore, notwithstanding the great longitudinal extent of the electric centre, the number of cells is not so very great. I estimated the total number of cells to be about 60,000—not many more than the estimated number in the Torpedo.

The genus Mormyrus, whose electric power was doubted until quite recently, resembles the Gymnotus in the structural arrangement of its electric apparatus. I was fortunate enough to find the ganglion cells for the electric nerves in the spinal cord, where the tail is endowed with the electric batteries, as seen in Fig. 1. The cells are very soft, and must be very carefully preserved to show all their details. Their regular undivided axis cylinders leave the cord-like motor roots, and form a sort of plexus before leaving the vertebral canal. It is to be considered as a very important fact, that broad processes of the cells regularly intercommunicate on so large a scale that their union into a complete system for simultaneous action cannot be doubted.

Fig. 3 shows such cells in the grey substance of the spinal cord; the intercommunicating processes can be seen much more distinctly in the microscopic slide and even in a photogram, than they appear in that figure.

The axis cylinder of each cell being a well-defined undivided process, the intercommunicating processes must be regarded as protoplasmic in the sense expressed by Deiters. Their general intercommunication cannot have any other significance than to insure equality of action in giving the impulse to the electric batteries. If that statement be admitted *the protoplasmic processes of the cells must have a conducting function.* If that be true in the Mormyrus there is no reason whatever why it should be otherwise in other vertebrates. Yet Golgi maintains that the protoplasmic processes of nerve cells are to be regarded as having a simply nutritive and therefore a non-nervous function.

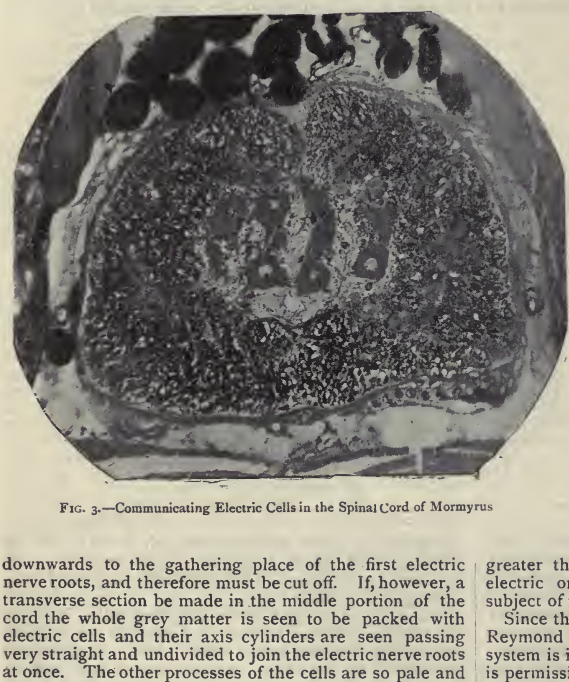


FIG. 3.—Communicating Electric Cells in the Spinal Cord of Mormyrus

There is another most remarkable fact in the organization of the Mormyrus having reference to the combined action of the electric organs on both sides. The upper as well as the lower electric nerves form a decussation outside the vertebral canal resembling the chiasma of the optic nerves. I am not acquainted with any other instance of motor nerves crossing the median plane to the other side of the body outside the cerebrospinal axis. In all other cases they are outside the brain and the spinal cord confined to their own side of the body to insure the isolated action of each muscle or group of muscles on that side. It is therefore stated that in changing the motor into an electric function these nerves at the same time became liberated from the strict rules of their predecessors. Certainly the case of Mormyrus gives a very good idea of the extraordinary power of adaptation to function with which Nature is endowed; but who can say how this particular anatomical arrangement could come about by gradual variation? I consider this difficulty far greater than that relating to the first development of electric organs in general which is so frequently the subject of reference.

Since the celebrated investigations of Prof. E. du Bois-Reymond have shown that the function of the muscular system is intimately associated with electric currents it is permissible to take them into account where muscle and their derivatives are under consideration.

I have shown elsewhere that most of the electric fishes are liable to a degeneration of the muscular system, seemingly caused—in part, at all events—by a certain lazy mode of life (disuse of organs). We therefore find along with fully developed electric tissue in the Gymnotus, nests of muscles which have not arrived at perfection. In the Mormyrus degenerating muscles in the forepart of the electric organ suggest the impression that the process of transformation is still going on. Still more is this the case in the common Raja.

Moreover, we know that the peculiar degeneration of muscular tissue into electric tissue destroys the contractile power of the muscles, but does not interfere with their

electromotor properties; on the contrary the loosened and differently arranged elements of the changed muscles are more capable of producing electric currents. In that

FIG. 4.—Transverse section through the body of Malapterurus with a parasite in the electric organ.

state of development which has still quite an occasional character, it seems only necessary to assume that under certain favourable circumstances the fish while trying to catch a prey or to defend itself against an enemy in the sudden excitement becomes aware of its electric power hitherto unknown to itself. On perceiving the advantage of the electric power in the struggle of life the fish might begin to use it regularly and to develop it gradually to perfection in its descendants; just as a man might one day perceive that he is endowed with the power of hypnotism, consequently learns to use it and gradually improves it.

But now it is necessary to consider also the electric Shadfish of the Nile, the *Malapterurus electricus*, a powerful fish of very peculiar structure, which places it in quite a different category from the electric fishes already mentioned. A transverse section of the whole fish (Fig. 4) shows the difference at once. The body of the animal is enveloped in a very thick electric skin, constituting one electric organ. Muscular tissue is nowhere deficient, other histological elements must therefore have furnished the material for the electric plates, which are packed very close in lozenge-shaped compartments of the skin.

In my opinion the plates are nothing else than modified cells of the cutaneous glands which are plentiful in the remainder of the skin. The precise proof of that statement ought to be furnished by a complete investigation of the development of the animal, which as yet is quite unknown. But the differences between the two kinds of electric organs are so great that we are surely entitled to separate the *muscular* from the *cutaneous* electric organs.

Assuming that the origin of these cutaneous batteries differs from those developed from muscle, we cannot wonder that their functions also differ in most important points. The electric current passes through the body in a direction the opposite of that in other electric fishes. There are *only two* electric nerve fibres, one on each side, which divide and subdivide until they give off more than two million branches. We shall see that these two nerve fibres are not true axis cylinder processes of ganglion cells. Before making a more detailed reference to these interesting elements it may not be amiss to point out in the section shown in Fig. 4 the existence of an intruder, a specimen of the so-called *Filaria piscium*, which had taken up its abode in the electric organ itself. This proves that animals can become accustomed to strong electric currents without receiving injury, and it suggests that the immunity of electric fishes against their own currents and that of their young *in utero* (Torpedo) is a faculty acquired by gradual training.

The construction of the single electric nerve fibre in Malapterurus resembles to a surprising extent that of an electric cable on a minute scale. We see the tiny nerve fibre like the central wire of the cable surrounded by a little non-conducting material and held *in situ* by a sort of network; the whole being enveloped in an enormous mass of connective tissue sheaths just like a cable protected externally by numerous layers of strong material. Fig. 5 shows a transverse section of the central part only to render the details of the round fibre and supporting network more distinct. If we follow this single fibre inwards to its origin in the central nervous system we are led to *a single ganglion cell* from which the single fibre arises. There is one cell on each side of the cord, therefore just two cells in all; whereas in Mormyrus, which has the smallest number of electric cells in the fishes with electric organs of muscular origin, the cells must be estimated at more than 1500. The position of the two cells in the spinal cord of Malapterurus reminds one of Clarke's column in the cord of higher vertebrates where the cells differ in certain particulars from the motor cells. As already stated there is only one cell on each side, but

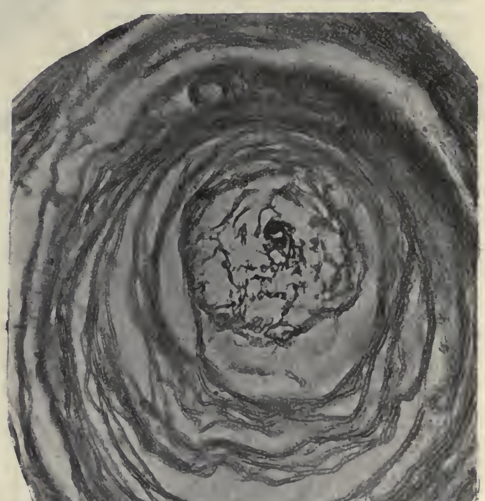


FIG. 5.—Transverse section of the central part of the electric nerve of Malapterurus.

that is a giant of its race. There is no real axis cylinder arising from the cell, but in place of it branched protoplasmic processes join and form a kind of perforated

plate beneath the cell, from which the nerve fibre starts with a broad base (Fig. 6). I consider this a chief point of difference between this peculiar cell and all the other afore-mentioned cells of a motor character. Fig. 6 gives a good idea of this magnificent histological specimen with its elegant nucleus showing its network and its nucleolus on one side.

Reviewing from a physiological standpoint the several facts stated above, we must feel convinced that the peculiar ganglion cells which are invariably found in relation to electric organs must play an essential part in bringing the electric organ into action. In my opinion that is tantamount to proof that other ganglion cells must be essential for sending nerve impulses to peripheral organs, and that the idea lately suggested by Nansen that ganglion cells have only a trophic influence on nerve tissue cannot be reasonably maintained in the face of these and similar facts. I may here refer to the well-known peculiar ganglion cells found in the motor region of the brain of higher animals, including man. Betz, who discovered them, searched for them for the purpose of stating anatomically the laws of localization found by Prof. Hitzig and myself.

It may not be out of place to adduce here another piece of evidence taken from the department of pathology. My friend and collaborator Hitzig has lately published the case of a man who died from tetanic cramp of the head. He observed that in the ganglion cells of the motor centre of the fifth nerve presiding the affected muscles there was a very singular change to be observed *in these cells only*. It appears that the bacteria of tetanus caused a granular decomposition of the protoplasm in the cells, which led to a further state of degeneration characterized by the appearance of large holes, while the other ganglion cells and the remainder of the organ appeared quite healthy. I am convinced the case shows that the cramps in the combined muscles resulted from the irritation and gradual disorganization of the ganglion cells.

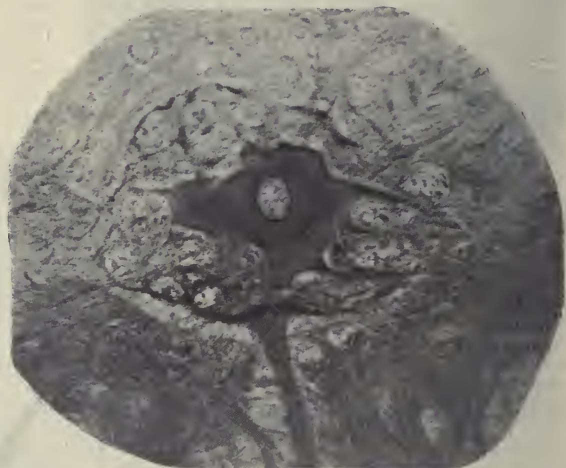


Fig. 6.—The right giant ganglion cell with the origin of its electric nerve from spinal cord of Malapterurus.

The above statements may suffice to show that the electric fishes and their nervous elements are really not such outsiders in science, and that the observations made on them should be brought into comparison and correspondence with those gathered from other sources. Indeed the histological elements in their organs are so instructive, that I would strongly recommend that the conclusions deducible from their study should be employed in maintaining well-founded former notions regarding the organization of the nervous system in vertebrates against certain revolutionary ideas of some modern authors.

Gustav Fritsch.
Physiological Institute, University of Berlin.

AUSTRALIAN TRAVELS.[1]

On opening this work, one is at once struck by the beauty of the illustrations, particularly those of the New Zealand Alps. The double-page plate opposite p. 248, drawn from a photograph taken by the author, is especially worthy of remark. For effect this view may well compare with some of the most picturesque parts of Switzerland. Some of the photographs, however, have a familiar appearance to the travelled reader; one recognizes in the beautiful picture "Off the West Coast of Ceylon" (p. 300) an old friend, none the less worthy of reproduction.

The work makes no pretensions to a virgin freshness its professed object being to gather together the already published observations of the author, and to present them in a popular form. This it does very successfully, though the English reader could have dispensed with a good deal of the very apparent "padding." Thus the first twenty pages of this book of travel are devoted to the history of Australia, and remind one of Coghlan's opening chapter in the "Wealth and Progress of New South Wales": the next twelve pages on gold differ from Coghlan's second chapter, particularly in giving greater prominence to Count Strzelezki's discovery, and one regrets that n mention is made of James McBrian, who certainly ha prior claims. The author is candid in his criticisms and condemns both the theatres and University of Sydney, as being, from the German standpoint, decidedly bad. On p. 34 we come to a "Journey into New South Wales," and here commences an interesting medley of natural history, traveller's tales, and geographical investigation. In this vacation ramble Von Lendenfeld claims to have discovered the culminating point of the Australian continent in Mount Townsend, to which he assigns (by aneroid) the height of 2241 metres. The doggerel verse on p. 82, in which a red sunset is taken to indicate approaching rain, must be wrong in its meteorology, so at least it proved, a red sunset being followed, much to Lendenfeld's surprise, by a fine day. It is satisfactory to find that the signs of the weather are not inverted at the Antipodes.

The author's familiarity with glaciers and ice-action in Europe served him in good stead in the southern hemisphere. Several interesting pages are devoted to his discovery of the former existence of glaciers in the Australian Alps; though there seem to have been contemporaries in this matter, for while Von Lendenfeld's observations proved the existence of *moutonnéed* and striated surfaces down to a level of 1500 metres above the sea—Mr. James Stirling claimed to have found signs of ice-action at lower levels still, as in the neighbourhood of Omao, where they occur at 800 metres above sea-level. The historical conscience is strong in the author, or he would scarcely have troubled to recall the

[1] "Australische Reise," by R. von Lendenfeld, pp. 325, with Illustrations. (Innsbruch: Wagner, 1892.)

fact, that when his communication on the discovery of glacial markings was read before the Geological Society of London, it was received with scepticism by Prof. Bonney (and, let us add, though the author does not, by Dr. Blandford also). On turning to the *Journal* of the Society we find that Prof. Bonney considered the observations then adduced by Von Lendenfeld as insufficient to establish his conclusions, and in this opinion we fancy most geologists will be inclined to agree with him. That the conclusions were right after all is a different matter. It is to be regretted that even in this, his latest published summary, Von Lendenfeld does not always supply us with facts on which we can base an independent judgment. The personal opinion of an observer, however skilled, can be no sufficient substitute for these. A single instance will suffice. An important joint expedition was undertaken by the author and Mr. Stirling to examine into the accuracy of the latter's statements as to the downward extension of the ice. After several pages of interesting traveller's gossip we reach the result in words much to the following effect:—"After three-quarters of an hour's ride in the valley bottom we reached an old moraine, which we investigated closely. A dam 35 metres high and 200 broad composed of various (*verschieden*) great blocks of rocks with sharp angles stretched across the valley. A brook flowed through the middle. We are here at a height of from 900 to 1000 metres, and since it is a veritable moraine Stirling is right and our dispute is ended."

We will not offend the susceptibilities of the author by questioning whether this is really a moraine: probably it is; but no convincing proof of the fact appears in the description. One would like to know whether other signs of ice-action were observed in the immediate neighbourhood, in what respects the fragments differed from each other and from those of the adjacent valley slopes, and especially what evidence existed to show that they had been carried down the valley, and how far they are removed from their source. This information could have been conveyed in a few words, and would have been welcomed by inquiring minds, who now may wonder whether after all this dam could by any chance be merely the remains of an ancient landslip. New Zealand is introduced to us on p. 161, and after a short historical account we pass on to the New Zealand Alps and fjords. With regard to the latter the author stoutly maintains their glacial origin: one of his chief arguments resting on their great epth as compared with the sea into which they open. They are apparently submerged rock basins, but although the author may be right in his contention that they are not merely moraine-dammed valleys, yet he altogether overlooks another more probable explanation, depending on unequal subsidence: submergence of the land has certainly taken place, and one has only to concede that the central mountain masses have sunk to a greater extent than the adjacent sea-floor to understand how the previously existing valleys would be converted into fjords. The greatest depth of Milford Sound is 360 metres, and one must travel (so our author tells us) at least 100 kilometres from the coast before this depth is reached at sea; now as the watershed is distant only 30 kilometres from the coast, it is at least as probable, considering the gradient, that we have to do here with differential movements of the land, as with locally concentrated erosive action.

An ingenious attempt to explain the last glacial episode leads to several bold generalizations. The author commences with the assertion that the whole of the southern hemisphere is at present much more severely glaciated than the northern, indeed he goes so far as to state that the northern hemisphere in the middle of the ice period was not much more severely glaciated than the southern is now. Since the mean temperature of the southern is not lower than that of the northern hemisphere the reason for its excessive glaciation must lie in a more uniform climate and a damper atmosphere; and these again are a direct consequence of the greater extent of the oceanic surface.

Let us now suppose the sea-level in the northern hemisphere to rise 100 metres, the lowlands will become submerged (as during the last glacial episode they apparently were) the climatal conditions will then approach those now prevailing in the southern hemisphere, and excessive glaciation will result.

But in the southern hemisphere also, the ice was formerly of much greater extent, and this is not susceptible of the same explanation, since a depression of the land would not greatly affect the existing climate. What, however, would be the effect of a depression of the sea level? The submarine slopes of most of the land in the southern hemisphere are so steep that the present distribution of land and sea would not be largely modified, though the latter should sink 300 metres; on the other hand, the increase in the height of mountains (300 metres) would lead to a descent of the snow line, the growth of snow fields, and a corresponding enlargement of glaciers. Thus the glacial episode in the northern hemisphere might be attributed to an elevation of the sea-level, that in the southern to its depression: and these changes of level may have been produced by a bodily movement of the ocean waters from one hemisphere to the other, a result itself possibly due to a shifting of the centre of gravity of the earth. The author does not explain how to shift the centre of gravity of the earth.

We notice that the author speaks with disrespect of the maps of the Tasman glacier by Mr. W. S. Green, stating that they are nothing like so good as Von Haast's; since however, later explorers prefer them to Von Lendenfeld's own, it would appear that we have here a descending scale of excellence.

After pointing out the failure of Mr. Green to reach the actual summit of Mount Cook, the author gives a glowing account of a successful ascent of his own, not of Mount Cook however, but of the Hochstetter Dome! He therefore claims to be the first who has set foot on the top of a high mountain in New Zealand. We offer him our congratulations.

In commenting on the author's style, which in its lucidity is far more English than German, we must offer a serious protest against his manner of using what he terms our "transcendentally intense adjective." Bob Acres' remark that, "The best terms will grow obsolete. Damns have had their day," does not appear to apply to Australia, where, to judge from our author, they flourish along with other survivors of a Mesozoic age.

AMERICAN FORESTRY.[1]

COMPETENT English authorities on forestry are so rare that no apology is needed for presenting some extracts from a translation from the German, of an important paper by Sir D. Brandis on American forestry. This is in continuation of a similar translation which appeared about a year ago in the columns of NATURE (vol. xliv. p. 60).

Upwards of 1,000,000 acres of forest are required for the annual supply of wooden sleepers for European railways. These forests are properly managed so as to yield a steady return, whilst nothing of the kind can be said of American forests. This explains why German foresters are interested in watching the progress of forest destruction in America, where it is now merely a question of ten or

[1] "The Silva of North America." By C. S. Sergent, vols. i.–iv. (Boston and New York. Houghton, Mifflin and Co., 1891–92). Notes on the above by Sir D. Brandis, K.C.I.E., F.R.S., in *Zeitschrift für Forst und Jagdwesen*, October, 1892.

fifteen years before a timber famine must occur, which will greatly enhance the value of European forests.

Brandis explains the present lamentable state of affairs in the United States, as follows:—The Timber Culture Act, which was in force in certain of the States, provided that settlers should plant up with trees one quarter of the area allotted to them, and it was thus hoped to obtain forests in the treeless regions between the Rocky Mountains and the Mississippi river. Large tracts of land have been occupied under this Act, but very little progress has been made in afforestation. It is not difficult in the Republic for people to neglect engagements they have made with the State. It has been recognized for some time past that this law has been practically of little use, and it was therefore abrogated in March, 1891. The law abrogating it, in section 24, empowered the President to demarcate and reserve certain tracts of State forest. Great hopes were therefore entertained, and soon afterwards a proclamation was issued largely extending the Yellowstone Park, in Montana, on the borders of Canada.

This measure had been strongly supported for some time past by the American Forestry Association. The Park is a mountain forest tract on the water-parting between the Rivers Columbia and Missouri, and its preservation and proper management is of immense importance. In October, 1891, the extensive forest tract in Colorado in the Rocky Mountains, in which several large tributaries of the Colorado river have their rise, and containing 1,365,000 acres, was proclaimed as the White River Forest Reserve. It was also expected that a portion of the western slopes of the Sierra Nevada, bordering on the Yosemite National Park, and other localities where the *Sequoia gigantea* flourishes, would be proclaimed as State reserves. These two national parks were previously reserved under older laws. The numerous intelligent friends of forestry in America confidently expected that a beginning would now be made in the demarcation of extensive State forest reserves, and in their scientific management.

The most recent news from America, however, has thoroughly upset these expectations. A Bill has been introduced into Congress, to hand over most of the Yellowstone forest reserve to a railway company. It is considered certain that this Bill will pass the Lower House, and it is not expected that the Senate will refuse to sanction it. Wood merchants, mining speculators, and sheep owners are vigorously agitating against the proposed reserve in the Sierra Nevada, and it is feared that their agitation will carry the day.

The American Forestry Association, which held its tenth annual meeting last January, has "memorialized" the President that instead of making a few reserves here and there, he should proclaim the reservation of all State forests still left to the Union, and arrange for their proper management. Friends of the forest are numerous in America, and insight into the essential necessity of forest protection is spreading, owing to the numbers of Americans who travel in Europe, but in a land where the dollar rules, and where an individual who will not recognize its authority is considered a fool, any steady progress towards State forest management cannot be expected.

Bernhard Fernow, the chief of the Forestry Branch of the Ministry of Agriculture at Washington, still hopes for action in this direction on the part of Congress and the State Executive. At the last meeting of the Forestry Association he rightly urged that æsthetic and sentimental grounds for improving American forests must be left entirely in the background. Only where important material interests are concerned, such as securing a continuous supply of wood, or a supply of water, or climatic considerations, should the State limit the freedom of its citizens in dealing with forests. If, however, for urgent reasons of public utility, it should be necessary to reserve a forest, the State should not be contented with merely demarcating and protecting it, but should introduce scientific management, so that the neighbouring populations may be able to utilize the forest produce; and in any case, all pre-existing rights acquired by the people in the forests should be strictly protected. Fernow concludes with the strongly-expressed advice that a law should be passed reserving the relics of the forests of the Union, and preventing any fresh alienations. He firmly believes that such a law is most urgently required. It is, however, quite a different matter for Congress to pass any such law, though more may perhaps be expected from the separate States in the Union, and in those of New York and California some rather halting steps have been taken in the right direction.

As matters stand at present in the United States, it is pretty obvious that a time will come when landowners will look upon their private forests as a good investment, for prices of wood and other forest produce are steadily rising. Little progress has, however, yet been made in this direction, and recent attempts made by some rich men to manage their forests properly with advantage have failed.

Sir Dietrich Brandis then turns to the progress made in the study of American forest trees, and states that literature on the subject is pretty abundant, but is after all merely thrashing straw. What is wanted in America is a practical proof that in forests of the Weymouth pine, of Minnesota, or of Californian red wood, or of Douglas fir in Washington and Oregon, or in the splendid mixed broad-leaved forests of the Alleghany mountains, good forest management will prove more remunerative than wasteful pillage (*Raubbau*).

The remainder of Brandis's paper is chiefly of botanical interest, and greatly praises Sergent's magnificent work. One other passage is too interesting to be omitted. It refers to the mesquit tree, *Prosopis juliflora*, which belongs to the dry zone in the south-west of the United States, and is also found in Mexico, and in the Andes as far as Chili and Argentina. In the river valleys of Arizona, where, although the air is dry, yet subsoil water is near the surface of the ground, this species forms extensive forests. On drier soils the aerial parts of the tree are reduced, but the root system is greatly extended. Sergent states that while the stem may be only a few inches high, and may only bear a few leaves, yet the tap root goes straight down to the subsoil water, and the aerial growth of the tree furnishes a clear indication of the depth at which the latter may be found.

Wherever the mesquit is a tree the subsoil water is forty to fifty feet down, where it is a small shrub it is from fifty to sixty feet down, and wherever the roots descend over sixty feet, the plant is not more than two or three feet high. In the scantily-wooded districts, where the mesquit tree grows, its roots yield most of the firewood, and are dug up, or dragged by oxen from the ground. *Prosopis spicigera* in the drier parts of India similarly furnishes fuel and cattle fodder in the Punjab, Sindh, and parts of Berar. This tree, there termed the *Jhand*, sends down its roots to a depth of fifty feet and more, to the subsoil water, and thus produces wood in a dry country, providing the peasant with fuel and wood for his plough.

W. R. FISHER.

JOHN STRONG NEWBERRY.

IT is not only in the United States that the death of this veteran of scientific research will bring widespread regret. To many geologists and palæontologists in this country and on the Continent he was personally known, and those whom he honoured with his friendship will feel keenly the loss they now sustain. He was born at New Windsor, Connecticut, on December 22, 1822,

and took the degree of M.D. from the Cleveland Medical College, Ohio, in 1848. Before beginning the practice of medicine, which he intended to be his occupation in life, he spent two years in Europe. During his stay at that time in Paris he acquired a good knowledge of the French language, and had many opportunities of cultivating a love of science, which soon manifested itself as one of his distinguishing characteristics. Returning to his native country, he began practice as a medical man at Cleveland in 1851. Even at the outset of his professional work he contrived to find time also for scientific enquiry. His first published paper appeared in the same year in which he started in his medical profession. It is devoted to the geographical distribution of land and fresh-water shells.

But he soon entered upon the two branches of geological investigation in which he was to make his name familiar all over the civilized world—the study of fossil botany and of fossil fishes. As early as the year 1853 he made his first contribution to the history of Carboniferous plants, and three years later his earliest memoir on fossil fishes was published. By this time his scientific acquirements and enthusiasm were widely known. Hence when an expedition under Lieutenant Ives was organized for the exploration of the Colorado River of the West, Newberry was selected to accompany it, and to take charge of the observations to be made in natural history. His geological contribution to the famous Report at once placed him in the very front rank of American geology. His account of the geological structure of the region traversed by the expedition, and of the marvellous denudation of the cañons, will always remain as one of the landmarks of geological progress.

He had now been touched by the fascination of exploration in the far west. The drudgery of medical practice became irksome to him, so that when in the year following his return from Colorado the offer was made to him to take part in another expedition, he gladly availed himself of the opportunity. He accordingly accompanied Captain Macomb in an exploring expedition in the summer of 1859, from Santa Fé, New Mexico, to the junction of the Grand and Green Rivers of the Grand Colorado. This journey forms the subject of another masterly report by him, which, however, was not published for some sixteen years.

The shadows of the coming great Civil War were already falling on the United States, when Newberry was at work on the preparation of the record of the results of his western journeys. The storm at last burst in 1861, the same year in which his Colorado report was issued. Among the many scientific men who placed their services at the disposal of the North, Newberry took a foremost place. His medical skill and wide general scientific knowledge enabled him to be of great use to the army. He specially distinguished himself in the organization and administration of the hospital department. Among the reminiscences of his not uneventful life he had many graphic tales to tell of his experiences during that momentous epoch in the history of the United States. After the close of the war in 1865 he returned with renewed ardour to his scientific labours, and specially devoted his energies to the study of the ancient floras and fish-faunas of North America. Among his numerous memoirs on these subjects the two large monographs forming vols. xiv. and xvi. of the series published by the United States Geological Survey are specially worthy of notice. But they represent only a part of the enormous mass of material which he had worked over.

Prof. Newberry early in his career saw how great was the aid which geology could afford in the development of the mineral industries of his native country, and he gave himself with great energy to the practical applications of the science. He became one of the highest authorities on mining matters in the country, and he was mainly instrumental in the equipment of the great mining school of Columbia College, New York. He occupied the Chair of Geology in that establishment, and threw himself heart and soul into its duties. At last, in the midst of his work and honours, a stroke of paralysis disabled him from active duties, and he grew gradually feebler until his death. With him American science loses one of its most honoured and distinguished cultivators. His piercing eyes and well-cut features made him a marked figure in any assembly, while his courtesy and gentleness, and his unfailing helpfulness and serenity, gave him a charm which will endear his memory to a wide circle of friends.

A. G.

NOTES.

ALL entomologists in the country will learn with great satisfaction that the Treasury has consented, on the recommendation of the Trustees of the British Museum, to make provision in the estimates for the coming financial year for the purchase of Mr. Pascoe's well-known collection of insects. The importance of the acquisition of this collection by the nation is very great, as it contains an immense number of types, especially of the families Longicornes and Curculiones, to which Mr. Pascoe devoted so much attention for a period of more than forty years. Its dispersal or removal to a foreign country would have been an irreparable loss to British entomologists.

THE medals and funds to be given at the anniversary meeting of the Geological Society of London on February 17 next have been awarded as follows: The Wollaston Medal to Prof. N. S. Maskelyne, F.R.S.; the Murchison Medal to the Rev. O. Fisher, the Lyell Medal to Mr. E. T. Newton; and the Bigsby Medal to Prof. W. J. Sollas, F.R.S.; the balance of the proceeds of the Wollaston fund to Mr. J. G. Goodchild; that of the Murchison fund to Mr. G. J. Williams; and that of the Lyell fund to Miss C. A. Raisin and Mr. A. Leeds.

BETWEEN June 10 and 18 the University of Montpellier will celebrate the third centenary of the foundation of its Botanic Garden, on which occasion it is intended to invite a general congress of the botanists of all nations.

A MEETING of the Association for the Improvement o Geometrical Teaching was held on January 14, at University College, Gower Street, the chair being taken by the Master of St. John's College, Cambridge. The reports of the Council and treasurer having been read and adopted, Dr. Wormell was elected President for 1893, the hon. secretaries (Mr. E. M. Langley, 16, Adelaide Square, Bedford, and Mr. C. Pendelbury, 4, Glazbury Road, W. Kensington), and the other members of the Council being re-elected. Dr. Wormell having taken the chair, Mrs. Bryant gave a model lesson on geometry to a class of about twenty ladies. After an adjournment papers were read by Mr. G. Heppel on the use of history in teaching mathematics, and by Mr. F. E. Marshall on the teaching of elementary arithmetic. The attendance was larger than usual, and interesting discussions followed the lesson and the papers.

A DEPARTMENTAL committee, consisting of officers of the Charity Commission, the Education Department, and the Department of Science and Art has been appointed by Mr. Acland, Vice-President of the Committee of Council on Education, to consider the question of the organization of secondary education in England and Wales, and the relation of the Departments among themselves in connection with this subject. The Committee consists of the following members:—The Vice-President of the Council (chairman), Sir H. Longley, K.C.B., Chief Charity Commissioner, Mr. T. E. Ellis, M.P., Parliamentary Charity Commissioner, and Mr. Fearon, Secretary to the

Charity Commissioners, representing the Charity Commission; Mr. Kekewich, C.B., Secretary to the Committee of Council on Education, and the Rev. T. W. Sharpe, her Majesty's Senior Chief Inspector of Schools, representing the Education Department; and Major-General Donnelly, C.B., Secretary of the Department of Science and Art, Captain Abney, C.B., F.R.S., Assistant-Director for Science, and Mr. Armstrong, Director for Art, representing the Department of Science and Art, Mr. H. W. Simpkinson, Examiner in the Education Department, acts as Secretary to the Committee.

On the 25th inst. an influential deputation will wait upon the President of the Board of Trade to urge the adoption of the decimal system of coinage and weights and measures in Great Britain. Among those who propose to form part of the deputation are the Agents-General for Victoria, Queensland, and the Cape, and several prominent members of the various chambers of commerce.

The Infant University of Chicago seems to be resolved to arrange its staff of teachers on a scale commensurate with the size of the North American Continent. Thus, the Department of Geology is placed in the hands of no fewer than seven distinct professors and two assistant professors, each taking some special branch of this wide science under the competent leadership of Prof. T. C. Chamberlin. Three of the professors are non-resident, but they will probably give occasional lectures, and will at least direct the studies in their own branches of research.

Mr. John D. Rockefeller, who had already presented the University of Chicago with 2,600,000 dollars, has now given it another million. The university owns land, buildings, and other property valued at £1,400,000 sterling, and the principal is ambitious enough to hope that in course of time it may have "such an array of magnificent buildings as one sees at Oxford or Cambridge."

A botanical laboratory has been established at Eustis, Lake co., Florida, chiefly for the investigation of diseases of the orange and other species of *Citrus*, under the direction of Prof. W. T. Swingle. The anatomy, physiology, and pathology of other sub-tropical economic plants will also be investigated.

On Saturday last Prof. Flinders Petrie delivered his first lecture as professor of Egyptology at University College, Gower Street. In the course of the lecture he said that, besides more than a thousand photographs and various impressions or "squeezes" of sculpture, a collection of original objects would be exhibited for the close examination of students. Miss Edwards had formed a collection with much care—as complete and typical as possible. He hoped also to place on loan his own collection, and to have a series of annual loan exhibitions drawn from the many valuable private collections in England. There would thus be found a collection of deities, the most complete collection of scarabs, the only chronological collection of beads, a dated series of pottery, the largest collection of funeral cones, and also of Egyptian weights. In certain lines of study their museum would not be merely supplemental, but would be in advance of any historical museums. He proposed to give a series of lectures in the autumn and spring, and would prepare students who might wish to undertake practical work in Egypt, where he would spend the time before Christmas to Easter.

Mr. Rowland Ward is exhibiting in his studio a valuable collection of African trophies and curiosities, most of which have been brought to England by Captain Lugard and Mr. F. C. Selous. Besides natural history specimens, the collection includes many weapons and products of native art.

Another severe loss has been sustained by science in Russia through the death of the well-known mineralogist, Nikolai Ivanovitch Koksharoff. He died at St. Petersburg on January 2. He was born on December 2, 1818, in West Siberia, in a village near which at that time was the fort of Ust-Kamenogorsk, and he made his studies in the Mining Institute at St. Petersburg. In 1841, when he was a mining engineer in the Urals, he accompanied Murchison on his journey to Russia and to the Urals, and the intercourse with the great geologist led him to adopt a scientific career. He spent the next three years studying in Western Europe, and on his return he devoted himself entirely to minerology, and especially to goniometric measurements of minerals, in which he was so much aided by his wife that his numerous writings on this subject are as much her work as his. He lectured in his early years on geology and physical geography, but later on devoted himself almost entirely to the description of Russian minerals, of which he discovered and described many new ones. His chief works are embodied in eleven large quarto volumes of "Beiträge zur Mineralogie Russlands," illustrated with numerous plates. The twelfth volume was in type when he died. In 1866 he was made a member of the St. Petersburg Academy of Sciences, and many scientific bodies of Western Europe elected him corresponding or honorary member.

During the past week the weather has been of a very unsettled character; at first an anticyclone lay over the greater part of these islands, while areas of low pressure were situated over the North Sea and to the west of Norway. With these conditions the weather became warmer in this country, the daily maxima varying from 40° to 46°, but over the Continent very low temperatures continued to be registered, the minima in Sweden varying from 60° to 65° below the freezing point, while exceptionally severe weather also prevailed over France and Germany. On Sunday a depression was passing to the southward of these islands, and under its influence north-easterly gales were experienced in the eastern and southern parts of England; a sharp frost occurred over this country, accompanied by snow in most parts, while a thaw set in over Scotland and rapdidly spread southwards, accompanied by rain, the maximum temperatures reaching from 45° to 50°. Subsequently the conditions were again becoming anti-cyclonic, accompanied by a return of colder weather, but they were not at all settled; snow was falling on Tuesday in the south of England. For the week ending the 14th instant the temperature was everywhere below the mean, the deficit ranging from 2° to 5°. The amount of bright sunshine exceeded the average in the north and west of Scotland and in the south-west of England; elsewhere the amount recorded was very small, being only 3 per cent. in the north-west of England.

Das Wetter of December last contains an account of a heavy thunderstorm which occurred at Paderborn on August 9, 1892, in which a number of living pond mussels were mixed with the rain. The observer who is in connection with the Berlin Metereological Office sent a detailed account of the strange occurrence, and a specimen was forwarded to the Museum at Berlin, which stated that it was the *Anodonta anatina* (L.). A yellowish cloud attracted the attention of several people, both from its colour and the rapidity of its motion, when suddenly it burst, a torrential rain fell with a rattling sound, and immediately afterwards the pavement was found to be covered with hundreds of the mussels. Further details will be published in the reports of the Berlin Office, but the only possible explanation seems to be that the water of a river in the neighbourhood was drawn up by a passing tornado, and afterwards deposited its living burden at the place in question.

MR. C. F. MAXWELL writes to *Science* from Dublin, Texas, that on the night of November 29, about 8 o'clock, a very large meteor was seen passing westward, a little to the south of that place. Just as it seemed to be passing the body exploded, producing a sound that was distinctly heard, resembling that of a rocket explosion or a pistol-shot. After the explosion a body half as large as a full moon moved away to the westward, making a hissing or frying sound. Mr. Maxwell has seen no one who saw the meteor before the explosion. The whole country was brilliantly lighted for a moment as if by a continued electric discharge, but at the time of the explosion the light was red and blue, or perhaps violet. The sound of the explosion was heard by parties five miles west and seven miles east of Dublin, who could not have been less than ten miles apart on an air-line, and they report the sound together with the other phenomena to have been about the same as they were at Dublin.

WHEN commanding the *Naiade* during the cyclone of November 6, 1891, Rear Admiral Cavelier de Cuverville had the opportunity of testing the efficiency of oil in calming the troubled waves of the North Atlantic. The last number of the *Revue Maritime* contains an account of his experiences and conclusions. When the waves threatened to become dangerous he gave orders to fill two coal sacks with tow steeped in oil, one of them to be suspended freely at the extremity of a spar spanned to the cat-head, the other near the bridge. The effect was excellent. No seas were shipped, and the vessel escaped without breaking a spar. It appears that the oil takes effect upon the "breakers" due to horizontal translation produced by the wind, leaving the orbital motion or "swell" unaffected. The former is the only element of danger in a rough sea. It was found that two sacks, filled with 5 kgr. of tow, holding 5 litres of colza or machine oil each, were sufficient to protect a vessel 75 m. long. The oil had to be renewed every six hours. Too much oil has the disadvantage of spreading more slowly, and theoretically the best system of distribution would be one in which the oil would reach the surface from below in a large number of small drops.

HERR J. NAUE has been fortunate enough to discover at a prehistoric station near Schaffhausen a piece of limestone, on both sides of which are drawings like those which have been found in caves in France and in the cave at Thayngen. It was found in the lowest part of the yellow "Kulturschicht" among bones and teeth of reindeer, horses, and other animals. On one side are a horse, a foal, and a reindeer, while several horses appear on the other. The style is not so fine as that of the Thayngen drawings, but, according to Herr Naue, they display a power of keen observation, and he points out that it was more difficult to work on stone than on a bone still fresh.

THE remarkable address delivered by Prof. Virchow on his assumption of the office of Rector of the University of Berlin has been issued by the German publisher, August Hirschwald, of that city. The title is "Lernen und Forschen."

THE *Pharmaceutical Journal* of the present week prints the first of what promises to be a good series of papers, which are intended to make bacteriology intelligible and interesting to students, and to be of some practical value to pharmacists in business. The *Journal* rightly thinks that the time has come when pharmacists ought to make themselves familiar with the principles of "this newest department of experimental science."

LAST week Lord Kelvin delivered an interesting speech at a dinner given to the members of the new watch factory at Prescot. He said it was something to be proud of that the article they were making was a triumph of mechanism. There was nothing in the whole of scientific art, nothing in the results of mechanics applied to the useful purposes for mankind, that was a more splendid success than the science of watchmaking. He had been all his life engaged more or less with scientific experiments, with measurements, and with instruments which their French friends would call instruments of precision. They knew something of instruments of precision in electricity, and they were thankful if they could make a measurement which was accurate to one-tenth or one-twentieth per cent. But what did watchmaking do? The commonest cheap watch—cheap but good—which would issue from the Prescot works would keep time to a minute a week. Now a minute a week, if they made a little calculation, was something like one-hundredth per cent. of accuracy, or just about ten times as accurate as they considered exceedingly good work in electrical measurements.

AT a recent meeting of the College of Preceptors, Mr. Foster Watson read a remarkably interesting paper on Richard Mulcaster, who was head-master of St. Paul's School from 1596 to 1598. The paper is printed in the current number of the *Educational Times*. Mulcaster's ideas were in some respects far ahead of those of his time. The following, according to Mr. Watson, were his "main educational contentions":—(1) Culture and learning for those who have the wit to profit by it, whether rich or poor. Adequate knowledge for those who go into trade. (2) Education for girls and women, as well as boys and men. Higher education for girls who have good abilities. (3) Training colleges for teachers. (4) Physical training for all—boys and girls, teachers and pupils, and this to be continued in after-life. (5) Liberal education, with disinterested aims for the elementary schools. (6) The best masters to take the lowest classes. (7) Drawing and music to be taught in every school, not as "extras," but as essentials. "You will notice," says Mr. Watson, "that the last-named five aims are only within the field of discussion even yet; they are not *faits accomplis*. All this time they have been in Mulcaster's book, and Mulcaster's book—a few copies of it, very few—have been gathering dust."

THE Association of Officers of Colleges in New England have recommended the gradual adoption of the following changes in the curriculum of New England grammar schools:—(1) The introduction of elementary natural history into the earlier years of the programme as a substantial subject, to be taught by demonstrations and practical exercises rather than from books. (2) The introduction of elementary physics into the later years of the programme as a substantial subject, to be taught by the experimental or laboratory method, and to include exact weighing and measuring by the pupils themselves. (3) The introduction of elementary algebra at an age not later than twelve years. (4) The introduction of elementary plane geometry at an age not later than thirteen years. (5) The offering of opportunity to study French, or German, or Latin, or any two of these languages from and after the age of ten years. (6) The increase of attention in all class-room exercises in every study to the correct and facile use of the English language. In order to make room in the programme for these new subjects, the association recommends that the time allotted to arithmetic, geography, and English grammar be reduced to whatever extent may be necessary. The association explains that it makes these recommendations in the interest of the public school system as a whole, but that most of them are offered more particularly in the interest of those children whose education is not to be continued beyond the grammar school.

MR. WALDO DENNIS gives in *Science* a minute and very interesting account of a snake which he watched for an hour in the woods one morning in July last. It went straight up a tree "without crook or turn," and by-and-by lay still for a while,

basking in the sun. Mr. Dennis notes that while in this position it lifted up its head four or five inches and gaped. Its mouth opened very wide; and when the mouth was closing, the nervous spasm, only half expended, again seized upon the jaws, whereupon they went wider than before, the spasm exhausting itself at last in a parting wriggle or two to the head. "So natural," says Mr. Dennis, "was this novel performance, that I involuntarily listened for that characteristic accompaniment, the little agonizing whine so common with the dog, and and not uncommon with us."

FEW things are more frequently said than that diseases of the nervous system, especially those of a hysterical character, have increased with the growth of civilization. Dr. de la Tourette has been trying to show, in the *Journal de Médecine*, that this is an error, and Dr. D. G. Brinton, in *Science*, expresses cordial agreement with him. Travellers who give the soundest information on the subject, says Dr. Brinton, report that in uncultivated nations violent and epidemic nervous seizures are very common. Castren describes them among the Sibiric tribes. An unexpected blow on the outside of a tent will throw its occupants into spasms. The early Jesuit missionaries paint extraordinary pictures of epidemic nervous maladies among the Iroquois and Hurons. During the Middle Ages there were scenes of this kind which are impossible to-day.

THE question as to whether electrification is produced by the friction of gases has been exhaustively dealt with by Mr. Wesendonck, who gives an account of his results in *Wiedemann's Annalen*. The apparatus resembled that employed by Faraday with negative results, in the case of dry air. Mr. Wesendonck used air compressed to 100 atmospheres in Elkan steel bombs of 1000 litre capacity. This was passed through a brass tube widening out into a cone into which a similar cone could be screwed from the opposite direction, so as to leave a conical path for the air issuing from the bomb. The second cone was connected to a delicate electrometer, which indicated any electrification produced by the impact of the air. Ordinary air was thus found to give considerable negative charges, up to $1\frac{1}{2}$ volt, if the cones were far apart, and positive charges if they were screwed up close. But no electrification was produced when the air had been previously freed from dust and moisture. Oxygen behaved in the same way. Carbonic acid, evaporated from the liquid state, imparted a strong positive charge to the brass, which was, however, reversed as soon as the cold led to the precipitation of water vapour. Ordinary atmospheric dust was found to electrify the brass negatively, the charge being increased by previous drying. It seems, therefore, that pure gases are incapable of producing electrification by friction, and that the effects observed are conditioned by the presence of minute solid or liquid particles.

FISHES in badly-ventilated aquaria give various signs of oppression, such as restlessness, frequent gasping, mounting to the surface, leaping into the air, &c. Experiments have been recently made by Messrs. Duncan and Hoppe-Seyler (*Zeitschrift für Phys. Chemie*) to ascertain to what point the oxygen-content of the water may be lowered before fishes indicate uneasiness. They were made with tench, trout, and crayfish in an elliptical glass vessel, with pipes for injecting and removing water and air, &c., in one case a pipe communicating with a chamber in which was a live rabbit, conveyed to the fishes air impoverished by the latter's breathing, while the behaviour of rabbits and fishes in the same air could be compared. With 4 to 3 cubic centimetres O in the litre of water, the fishes seemed well and content, and with the corresponding O tension in the air (8 to 11 volume-percentage) the rabbit was in no difficulty. With 1·7 to 0·8 cubic centimetres O in the water, the trout were evidently ill at ease, and, if it continued, they died. The tench and crayfish, however, stood still further reductions, the former finding relief at the surface. Reduction of the O to zero soon produced the worst symptoms.

IT was long ago shown by Sir J. B. Lawes that plants on ground that has been long without manure evaporate more water than those on good ground. Further research has proved that transpiration is not proportional to leafy development, for it largely depends on the activity of the roots, as well as evaporative surface. M. Dehérain has lately (*Ann. Agr.*) been led to investigate the influence of manure on the development of roots; and he finds that roots in unmanured ground have a much larger growth than in manured, having to spread more in search of the scanty nutriment. If, then, a plant with small leafy growth, evaporates more water relatively than one with large, it is probably due to large root-growth procuring more water. The observation of Volkens is cited, that desert plants have extraordinarily long roots. Further, M. Dehérain points out, the solar rays falling on a plant have a twofold work to do, viz. assimilation and transpiration. And these are complementary. In strong leafy plants there is vigorous assimilation, so that transpiration is limited; while in the leaves (with little chlorophyll) of an "anæmic" plant a larger fraction of the solar energy is given to transpiration.

IN the *American Geologist* an account is given of a preliminary examination of some specimens of a coaly mineral, having the general properties of a cannel, from the Kootanie and Lower Cretaceous of British Columbia. Their examination was of more than ordinary interest on account of their peculiar physical constitution and the great difficulty of ascertaining their connection with any of the materials ordinarily known to contribute to coal formation. The main characteristics of the mineral are the total absence of structure, and the presence of tubular ramuli resembling fungus mycelia, as well as rounded cavities. Angular fragments of material of the same nature as the larger rod-like bodies appear in the sections, and an amorphous substance either occurring in distinct flakes or acting as a cement to unite the rods. Mr. Penhallow's examination has made it probable that the origin of these coals must be sought in some other direction than modified vegetable structure. It is suggested that they represent a form of fossil resin accumulated during a period when resin-bearing trees were very abundant, and possessed a structure favouring the rapid disintegration of organic tissue.

A YOUNG lady in America seems to have the power of awakening not only the intelligence but the affections of insects. Her experiences are recorded in *Science* by a friend of hers, who signs himself "B." In September some one gave her a beetle, which is described as a specimen of *Pelidnota punctata* Linn. At first she kept it in a small box, feeding it with grass, leaves, and small pieces of fruits, such as peaches, pears, &c. Occasionally she would give it a drop of water to sip. It would sometimes bite a little out of a leaf, would eat the fruits, and would take water eagerly. From the first she would take the insect in her fingers several times a day and stroke or caress it, also putting it to her lips and talking to it all the while she handled it. When she put it to her lips it would brush its antennæ over them with a gentle, caressing motion. When she left her room she would shut it up in its box. One day, about two weeks after she received it, she was called out suddenly and neglected this precaution. She was absent for some time, and when she returned the insect was not in its box nor anywhere to be seen. Fearing that she might injure it, she stood still and called "Buggie, buggie," when it came crawling from its retreat towards her. "After this," says "B.," "she would frequently leave it free in the room when she went out, and when she returned, if the insect was not in sight, she would

call it, and it would crawl or fly to her. As this was continued, it would more and more frequently fly to her instead of crawling, until at last it flew nearly every time it was called. When it came in this way she would put it to her lips or to her nose, and the insect would appear to be pleased, moving its antennæ gently over her lips, or taking the end of her nose between them and touching it with a patting motion." Unfortunately this interesting beetle lost its liveliness in winter. It was placed on a cloth above the kitchen boiler, where it revived to some extent; but in December it accidentally fell to the floor and soon afterwards died.

THE annual report of the U.S. Commission of Patents for the year 1891 has been issued. In addition to the usual statistical information there are added to this report two tables and two diagrams illustrative of the growth of patent-granting from 1790 to 1890, the first century of the existence of the American patent system. The first table gives the patents granted in that period by years and by States to American citizens. The second table does the same for patents granted to citizens of foreign countries. The first diagram has one line illustrating graphically the growth of patent-granting during the century, along with another line denoting the increase of population in the same period. The second diagram has one line illustrating the growth per capita of patent-granting as a whole during the century, and other lines illustrating the growth per capita of patent-granting in the States by groups of States. There is also a list of patentees and their improvements, by years, prior to the year 1800.

THE first volume of the *Irish Naturalist*, a monthly journal of general Irish natural history, has just been published, and a very interesting volume it is. The editors are Mr. G. H. Carpenter and Mr. R. Lloyd Praeger, and they have secured from able contributors many good articles on subjects which cannot fail to be attractive to Irish readers. The volume also records work done by some of the foremost of the Irish scientific societies.

THE Bureau des Longitudes has issued, through Messrs. Gauthier-Villars et Fils, its "Annuaire" for the year 1893. It contains, as usual, a great mass of scientific information, clearly arranged. Among its "notices" is an interesting paper upon the observatory of Mont Blanc, by M. J. Janssen.

THE Belgian Royal Academy of Science, Letters, and Art has also issued its "Annuaire." Among the contents is a rather elaborate memoir of Jean Servais Stas, accompanied by an excellent portrait.

MESSRS. CHARLES GRIFFIN AND CO. have published a ninth edition of "A Pocket Book of Electrical Rules and Tables for the Use of Electricians and Engineers," by John Munro and Andrew Jamieson. The authors state that the work has been carefully revised and enriched with fresh matter, including several important communications by leading authorities on electro-technics.

MESSRS. GEORGE BELL AND SONS have issued the first portion of a supplement to the third edition of "English Botany, or Coloured Figures of British Plants." This part has been prepared by Mr. N. E. Brown. The rest will be done by Mr. Arthur Bennett.

IN our review of "Modern Mechanism" last week (p. 242) a typical American express locomotive with 20 × 24 cylinders was said to be less powerful than an 18 × 26 cylinder British engine. This should, of course, be reversed, the American engine being the more powerful.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♀) from India, presented by Mr. F. Skinner; eleven Tuatera Lizards (*Sphenodon punctatus*) from Stephen's Island, Cook's Straits, New Zealand, presented by Captain E. A. Findlay; a Puff Adder (*Vipera arietans*) from East Africa, presented by the Directors of the British East African Company; a Vulpine Phalanger (*Phalangista vulpina*), from Australia; a a Stanleyan Chevrotain (*Tragulus stanleyanus* ♂) from Java, deposited; a Sanderling (*Calidris arenaria*), European; two Brown Capuchins (*Cebus fatuellus*), an Azara's Fox (*Canis azaræ*), a Ring-tailed Coati (*Nasua rufa*), seven Glossy Ibises (*Plegadis falcinellus*), a Brown Milvago (*Milvago chimango*), four Barn Owls (*Strix flammea*), a Ypecaha Rail (*Aramides ypecaha*), a Chilian Pintail (*Dafila spinicanda*), a Geoffroy's Terrapin (*Platemys geoffroyana*) from South America, purchased; a Hog Deer (*Cervus porcinus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET HOLMES.—The following telegram was received from Dr. Copeland on Tuesday evening:—"Comet Holmes reported suddenly brighter. Stellar" (nucleus). We therefore continue the ephemeris. (Schulhof, for Paris, midnight.)

Date		R.A app. h. m. s.		Decl. app. ° ′
Jan. 19	...	1 25 53·2	...	+33 39
20	...	27 13·7	...	39
21	...	28 35·1	...	39
22	...	29 57·2	...	39
23	...	31 20·1	...	40
24	...	32 43·7	...	40
25	...	34 8·0	...	41
26	...	1 35 33·0	...	+33 42

The comet is now almost midway between β Andromedæ and α Trianguli.

BURNHAM'S DOUBLE-STAR OBSERVATIONS.—Mr. Burnham's splendid series of double-star measures, made chiefly with the 3-foot refractor at the Lick Observatory during the first six months of 1892, are published in *Ast. Nach.* No. 3141. He states that the superiority of the great telescope for this work has been fully demonstrated. In the present list there are micrometric measures of eight new double stars, and additional measures of 170 old ones. χ Pegasi has completed more than one revolution since its discovery in 1880, the period being about eleven and a half years, which "is probably shorter than that of any other known pair in the heavens."

Mr. Burnham's connection with the Lick Observatory having permanently ended in June last, the present list of measures concludes his work on double stars. It is to be hoped that the field of work which he has so brilliantly occupied will not be neglected in the future.

EPHEMERIS OF COMET BROOKS.—The following is a continuation of Kreutz's ephemeris for Berlin, midnight:—

Date.	R.A. (app.) h. m. s.		Decl. (app.) ° ′		Log r.		Log Δ.
Jan. 19 ...	22 58 23	...	+ 48 59·3	...	0·0835	...	9·9670
20 ...	23 5 14	...	47 36·7	...	0·0845	...	9·9786
21 ...	11 26	...	46 17·3	...	0·0856	...	9·9902
22 ...	17 4	...	45 1·2	...	0·0867	...	0·0017
23 ...	22 13	...	43 48·5	...	0·0879	...	0·0132
24 ...	26 56	...	42 39·0	...	0·0891	...	0·0245
25 ...	31 16	...	41 32·8	...	0·0904	...	0·0358
26 ...	23 35 17	...	+ 40 29·6	...	0·0917	...	0·0468

THE ECLIPSE OF APRIL 16, 1893.—In a communication to the Astronomical Society of France, M. de la Baume Pluvinel indicates some of the points to which attention should be directed in the eclipse of the sun in April. In the first place, he does not think any of the precious moments of totality need be devoted to the study of prominences, as these can now be completely studied at any time. The investigation of the corona is all-important, and attempts should be made to obtain photographs showing its general aspect with various exposures, as well as photographs of its spectrum. The different parts of

the corona are of such varying brightness that it will be impossible to obtain all the details with a single exposure. For the spectroscopic work it is also recommended that isochromatic plates be employed, with special reference to the distribution of the material which gives the green line 1474 Kirchoff. Mr. Lockyer proposes to use an objective prism, so as to obtain monochromatic images of the corona, that is, rings corresponding to each elementary radiation of the coronal light. This method will not only give the spectrum of the corona, but the distribution of each spectrum line over the whole of it. The problem of the "reversing layer" is also wanting definite solution, and it is pointed out that instantaneous photographs may settle the question once for all. M. Pluvinel also points out the importance of noting the presence or absence of the hydrocarbon bands suspected by Tacchini in 1883, as this observation may throw further light on the analogy between the corona and the tails of comets.

Photometric observations should also be secured, and the polariscope should be employed to determine the proportion of polarized light in various parts of the corona.

NOVA AURIGÆ.—Prof. Barnard has recently made some measures of the position of Nova Aurigæ, with a view to detecting proper motion. The two comparison stars selected were the stars E and F in Mr. Burnham's previous list of comparison stars. The results are stated thus (*Ast. Nach.* No. 3143):—"The measures with F come out identical with Mr. Burnham's during February, but those with E seem to show some sort of motion in distance and possibly in angle. From the position of the comparison star this can hardly be due to parallax. It is possible, though, if the discrepancy is a real displacement, that it is due to orbital motion, the orbit being so situated as to show no motion with reference to F. The difference is not sufficiently great, considering the distance, to prove anything." Prof. Barnard further remarks that although the Nova presented no nebulosity at its first appearance, it has always appeared as an undoubted planetary nebula since he observed it on August 19. Estimates of magnitude in the present condition of the Nova will depend greatly upon the telescope and magnifying power employed. Since August the nucleus has become fainter, while the light as a whole has remained essentially constant.

"ASTRONOMICAL JOURNAL" PRIZES.—"A gentleman earnestly interested in the development and progress of astronomy in his native land has authorized the editor of the *Astronomical Journal* to offer two prizes, for resident citizens of the United States" (*Ast. Jour.* No. 284). The prizes will either take the form of money or of gold medals, one being of the value of two hundred dollars and the other of four hundred dollars. In the first instance the prizes will be awarded for observations tending to advance our knowledge of cometary orbits, one being for the best series of measurements of the positions of comets during the year ending March 31, 1894, and the other for the best discussion of the path of a periodic comet, with due regard to its perturbations. With regard to the first, astronomers who hope to gain the prize must frequently be at work until sunrise, as special value will be attached to observations made at inconvenient hours.

GEOGRAPHICAL NOTES.

THE name Ibea, contracted from the initials of the Imperial British East African Company to designate their territory on the east coast of Africa, has acquired a certain amount of currency, and although open to philological criticism is practically convenient. On the same principle the great Dutch possessions in the East Indies have been termed Noi (*Nederlandsch Ost Indie*), and Mr. Ravenstein has suggested a similar abbreviation for the German East African territory (*Deutsch Ost Afrika*), only he would combine the initials with a Swahili affix or suffix signifying "land," and make it either Udoa, or Doani. The cumbrousness of using many words to specify a well-defined region seems to justify a somewhat bolder coinage of new names in geography than has hitherto been customary.

THE *Mouvement Geographique* publishes a sketch map of the Stanley Falls district of the Congo, compiled from the compass-bearings of M. Page, one of the members of the disastrous Hodister expedition. Besides Stanley, Lieutenant Gleerup and Dr. Oscar Lenz are the only other authorities on this stretch of the river. Special information is given regarding the three groups of rapids which occur between Stanley Falls station and Kibonge. The cataract of Mandombe above Stanley Falls is composed of a succession of falls from six to ten feet high and numerous rapids, but local canoe-men are able to take boats through in four or five hours. Three hours of free navigation leads to the rapids of Mamanga, where the river is barred from bank to bank by a ridge of rock about twelve feet high, and followed by rapids and other smaller falls necessitating a portage. Three and a half hours of free navigation lead to Basundu, the last cataract, which canoes are able to pass in about three hours after being lightened.

THE Antarctic whaling fleet, the dispatch of which was noticed in vol. xlvi. p. 477, has been reported from the Falkland Islands. The *Balaena*, which has the most complete scientific equipment, arrived at Port Stanley at the end of November, the *Active* on December 8, the *Diana* on December 11. The fourth vessel, the *Polar Star*, was spoken off the Plate on November 16. The telegram from Monte Video reports all well, and a preliminary notice of the scientific observations will probably follow by mail.

IN a communication to the Paris Geographical Society, M. Venukoff calls attention to the fact that although the extensive Government drainage works have almost obliterated the Pinsk marshes from the valley of the Pripet, the most recent non-Russian atlases continue to represent these marshes as they were thirty years ago. Now their site is largely forest and meadow-land.

TRAVELS IN BORNEO.

MR. CHARLES HOSE'S paper on "A Journey up the Baram River to Mount Dulit and the Highlands of Borneo," read to the Royal Geographical Society on Monday evening, was a pleasant variety in the succession of African papers which has formed the staple of the Society's programme for the session.

The Baram River runs on the whole northward through eastern Sarawak, reaching the sea in 4° 37′ 15″ N. and 115° 59′ 30″ E. Its mouth is complicated by a series of sandbanks shifting with the change of the monsoons. The river is in parts very deep, and is navigated by a fleet of Government steamers. The bordering land is low and swampy or covered with jungle until Claudetown, about sixty miles from the mouth, is reached. There the ground rises, and a prosperous trading town has been established by Chinese merchants. At Long Mari, about fifty miles further up, there are great rapids which can only be passed with difficulty, and gorges of considerable depth occur at intervals further up the stream. The journey to Mount Dulit was made up the Linjar, a large tributary of the Baram. The people on the banks of this river have a peculiar custom of keeping dead bodies in their houses encased in ornamental coffins for three months before burial; and Mr. Hose gave some highly interesting particulars regarding their burial customs, their complicated subdivisions of the world of the dead, and their habit of interchanging messages with departed friends. At the head of canoe navigation the Sibop tribe hunt various species of monkeys with the blowpipe, the valuable commodity being the intestinal calculi known as Bezoar stones, which are greatly in demand by Chinese apothecaries.

The ascent of Mount Dulit was commenced on September 21, when a hut was built at the height of 2000 feet, and a path cut through the thorny scrub to 4000 feet, near which another hut was built. Several days were spent here collecting natural history specimens, many of which were species new to science; amongst the smaller quadrupeds *Hemigale hosei*, and amongst birds *Calyptomena hosei* and *Mesobucca eximius* may be mentioned. A cave some distance higher was found with wild tobacco growing at its mouth and several remarkable ferns, one with fronds 14 feet long; but except for bats and a solitary snake, the cave was untenanted. The fauna of Mount Dulit closely resembled that of Kina Balu, showing the widespread distribution in the highlands of Borneo of Himalayan forms. The flat moss-clad summit of Mount Dulit was found to be, by aneroid, 5090 feet; and there was a magnificent view of distant ranges, the position of a number of peaks in which was fixed. Some natives reported having heard a tiger roaring in the neighbourhood, but Mr. Hose found the sound to proceed from a gigantic toad, measuring 14½ inches round the body. At the close of the paper Dr. Bowdler Sharpe F.R.S., pointed out the great importance of Mr. Hose's results in their bearing on geographical distribution.

BACILLI IN BUTTER.

THE fact that milk affords a particularly suitable medium for the growth and multiplication of most micro-organisms, has rightly led to its being regarded as a dangerous vehicle for the propagation of disease. On the Continent the practice of boiling all milk before use, and so destroying any pathogenic microbes which may be present, is almost universal, and recently a number of special pieces of apparatus have been devised for household use, ensuring the efficient so-called "pasteurization" of milk. In England, however, we but rarely boil our milk in spite of outbreaks of diphtheria and typhoid fever having been not infrequently traced to a particular milk supply. In a paper by Cnopf on the bacterial contents of milk it is stated, that on one occasion out of every thirteen samples of milk supplied to Paris one was found to contain tubercle bacilli, whilst it is well known that the germs of typhoid, cholera, diphtheria, anthrax, &c., thrive readily in this medium. But although milk has been made the subject of much careful experimental investigation, comparatively little is known of the microbial condition of butter. Heim has shown that cholera bacilli purposely rubbed into butter could be demonstrated after thirty-two days, whilst typhoid bacilli similarly introduced were found after three weeks, and tubercle bacilli after the lapse of a month, although Gasperini discovered the latter in butter even after 120 days. Quite recently Lafar has published a paper, "Bacteriologische Studien über Butter" in the *Archiv für Hygiene*, in which he has recorded his investigations on the micro-organisms found in Munich butter. These experiments are instructive as exhibiting the fitness of butter to support a large number of bacteria, and thus furnish an interesting supplement to what is already known concerning the longevity of pathogenic microbes in this medium. The samples examined were prepared from fresh cream and were investigated as soon as possible after the butter was made. It was found that the number of microbes differed according as the portion for experiment was taken from the outside or from the interior of the piece of butter. Thus in one instance whilst one gram from the centre of the pat contained 2,465,555, on the outside in the same quantity as many as 47,250,000 micro-organisms were found. Taking the average of a number of examinations, it was estimated that the interior of a lump of butter possessed from 10 to 20 millions of bacteria in a single gram. Lafar is inclined to regard this as an under rather than an over-statement of the number, inasmuch as there are always probably present a certain proportion of microbes which will not develop at the ordinary temperature, or on the gelatine-peptone medium usually employed. He graphically puts it that, in some cases it is conceivable that the number of organisms swallowed with a moderately-sized slice of bread and butter may exceed that of the whole population of Europe! Lafar found that butter kept in a refrigerator, with a temperature of between 0° to + 1° C. at first (after five days) showed a marked reduction in the number of bacteria, but that no further diminution took place, although the sample was kept for a month at this temperature. Samples kept at from 12° to 15° C. exhibited a marked increase in the number of micro-organisms, a rise from 6 to 35 millions being observed in the course of nine days, whilst when placed in the incubator (35° C.) after four days the bacteria had fallen from 25 to 10 millions, and after thirty-four days only 5 per cent. of the original number present were discoverable. Experiments were also made to ascertain what was the bacterial effect of adding salt to butter kept in a refrigerator. It was found that although the numbers were thereby considerably reduced, that yet, even when as much as 10 per cent. of salt was added, the complete destruction of the bacteria was not accomplished. On examining, however, gelatine-plates prepared from these samples, it was ascertained that the organisms present consisted almost entirely of a pure cultivation of one particular microbe, which was apparently entirely unaffected by the addition of salt, and had grown and multiplied to the exclusion of nearly all the other bacteria originally present. When samples similarly salted were placed in the incubator (35° C.) the result was rather different, for whilst there was more apparent connection between the proportion of salt added and the diminution in the number of bacteria, more varieties of micro-organisms were found on the gelatine-plates. But in this case, also, the germicidal effect produced was not proportional to the increase in the amount of salt. Samples of artificial butter were also examined, and were invariably found to be much poorer in bacteria than ordinary butter. Thus, whilst the smallest number found in one gram was 747,059, in real butter considerably over two million microbes was the minimum. Two varieties of bacilli have been isolated and described, which were found very constantly present in butter throughout these investigations. They are beautifully illustrated and shown in coloured plates as individual organisms and colonies at the end of the paper. Lafar purposes continuing his investigations, and it is to be hoped that the examination of butter for pathogenic micro-organisms, about which so little is known, will form an important feature in any further researches he may undertake.

GRACE C. FRANKLAND.

THE OCCURRENCE OF NATIVE ZIRCONIA (BADDELEYITE).

THE discovery of native zirconia was first made public in my letter to NATURE (vol. xlvi. p. 620) in October last; at the same time I gave characters sufficient for the recognition of the new mineral, and suggested the name *Baddeleyite*, in honour of Mr. Joseph Baddeley who had brought the specimen with other dense minerals from Rakwana in Ceylon. As there was only a single fragment of what at first sight seemed a hopelessly imperfect crystal, the determination of all the important characters without appreciable injury of the specimen was a task of an attractive kind: the technical details of the investigation (including quantitative chemical analyses) and the line of argument by which definite results were evolved from the observations, were communicated to the Mineralogical Society at the meeting held on October 25 (NATURE, vol. xlvii. p. 70), and crystals of hydrous zirconium oxychloride prepared by identical methods from Baddeleyite and artificial zirconia, respectively, were exhibited for comparison. Having regard to the unexpected result of the chemical examination and the difference of the characters of Baddeleyite from those of artificially prepared crystals of zirconia, every care had been taken to get results as accurate as the material itself would admit of.

Of course it was hoped that the occurrence of native zirconia, once established, would soon be noticed elsewhere; and in fact, I hear this morning (January 3) from Dr. Hussak of the Geological Survey of Brazil, that flawless crystals of zirconia are actually met with in the south of São Paulo as an accessory constituent of an augitic rock described under the name of Jacupirangite by my friend Mr. O. A. Derby.

The Brazilian mineral had three or four years ago been regarded by Dr. Hussak (who had then only a small amount of material for examination) as probably orthite (silicate of cerium, iron, &c.), a mineral with which it agrees in its more obvious external characters, and it was mentioned later under that name in Mr. Derby's description of the Jacupirangite; but more recently Dr. Hussak, on isolating a score of flawless crystals from the decomposed rock, recognized the distinctness of the mineral from orthite, determined the geometrical and physical characters of the crystals, and decided from a chemical examination that the material was a tantalo-niobate of probably some member of the yttrium-cerium group: these results were published in the *Neues Jahrbuch für Mineralogie*, 1892, Band II. p. 142, immediately after my announcement of the occurrence of native zirconia in Ceylon had been sent for publication, but they had been forwarded from Brazil as early as the month of June. Dr. Hussak now informs me that the Brazilian mineral, which had been sent to Sweden for a complete quantitative examination, has been determined by Prof. Blömstrand to be almost pure zirconia.

As regards crystalline form, the parametral elements obtained by myself for Baddeleyite, and announced at the meeting of October 25, agree in a very satisfactory way with those determined by Dr. Hussak for the Brazilian mineral, while as regards optical characters, the two descriptions are practically identical. The only important deviation of external character is in the specific gravity; that of Baddeleyite is 6·025, that of selected crystals of the Brazilian mineral is 5·006.

Now it seems almost impossible that the specific gravity of crystals of a simple oxide presenting otherwise identical characters can vary to this extent, and the explanation of all the difficulty will probably be found to be that Dr. Hussak's specimens really belong to two distinct minerals; that while the crystalline form and optical characters were determined from the one (zirconia), the specific gravity and the chemical composition

were originally determined from the other (yttrium tantalate). In fact, it was stated in my former communication that the Baddeleyite of Ceylon is itself associated with such a chemical compound; and I may add that this associated mineral was there designated without the mention of a species-name because it had been found to have a specific gravity (4·9) far below the inferior limit (5·5) hitherto observed in the case of undoubted Yttrotantalite: it was intended to determine later whether or not the lowness of the specific gravity was accompanied by a difference in the proportion of the chemical constituents; further, the similarity of aspect of the zirconia and yttrium tantalate of Ceylon is such that a confusion of the two would be easy. In this way the discrepancy of the chemical results and the complete accuracy of the observations of Dr. Hussak, whose reputation stands so high in the annals of mineralogical science, would be found consistent with each other.

There remains the inconvenience that two names have been suggested for the same mineral; but according to the rules of nomenclature formulated by Dana (rule 13*d*) the name of *Baddeleyite* has the prior claim. I may add that the name *Brazilite* was in use eight years ago, commercially at least, for the specification of an oil-bearing rock found in the neighbourhood of Bahia. L. FLETCHER.

GAS POWER FOR ELECTRIC LIGHTING.

AT the ordinary meeting of the Institution of Civil Engineers on Tuesday, January 10, an interesting paper on "Gas-Power for Electric Lighting" was read by Mr. J. Emerson Dowson. The author stated that in Great Britain alone gas-engines had been sold for electric lighting, exceeding in the aggregate 7000 horse-power, and that in Germany engines were used for about 1100 arc- and 90,000 glow-lamps. It was, however, only within the last few years that gas-engines of large size had been before the world in a practical form. The varying load-factor in central stations was a serious trouble, and the author hoped to show that much of the present loss, due to fuel, water, and wages, would be avoided if gas-power were used instead of steam-power.

Special reference was made to the central-station at Dessau, belonging to the German Continental Gas Company. That station was opened in 1886 with two 60 horse-power, one 30 horse-power, and one 8 horse-power (effective) engines, worked with town-gas, and all the dynamos were driven by belting and counter-shafts. In 1891 considerable alterations were made. One 60 horse-power engine, with its belting and counter-shaft, was retained, and one of 120 horse-power introduced, coupled direct to its dynamo. The speed of the engine and coupled dynamo was 145 revolutions per minute, and the consumption of town-gas was equal to 39 cubic feet per kilowatt. Formerly, without accumulators, it was thought necessary to adjust the size of the engines to the supply, so that they should always be worked to their full extent. It had, however, been found that a limited supply could more advantageously be furnished entirely from accumulators. In spite of the loss of about 21 per cent. in the accumulators, large engines worked more profitably in parallel than smaller ones supplying direct without accumulators. Since February, 1889, the Municipality of Schwabing, a suburb of Munich, had used an Otto engine worked with Dowson gas for 10 arc- and 300 glow-lamps. The load was variable, but with an average output of 22·5 kilowatts per hour the fuel-consumption was 3·3 lbs. per kilowatt. The town of Morecambe was lighted by nine arc-lamps and glow-lamps, equal to 1600 of eight candle-power each, the dynamos being driven by Stockport gas-engines worked with Dowson gas. With an output of only 1155 kilowatts per week the consumption of fuel was 2·58 lbs., and the cost of the gas, including wages and fuel, was ½d. per kilowatt delivered. At the château of Mr. Say, at Longpont, in the South of France, there were 650 glow-lamps and one arc-lamp, supplied by a dynamo driven by a Crossley engine worked with Dowson gas. The consumption of fuel was 1·2 lb. per indicated horse-power, and 2·7 lbs. per kilowatt per hour.

It was believed that the late Sir William Siemens first drew attention to the fact, that when illuminating-gas was burnt in a gas-engine to drive a dynamo, much more light was produced electrically than could be produced by burning the same quantity of gas in burners in the usual way. Latterly the consumption of gas per horse power in gas-engines had been reduced, and the ratio was at the present time about 20 to 1 in favour of converting the gas into an arc-light, by means of a gas-engine. The author had collected data from various sources, as to the consumption of ordinary town-gas by engines supplying electric light with and without accumulators. The average of all the returns, with engines under varying loads and without accumulators, was about 47 cubic feet per kilowatt-hour; when accumulators were used, the consumption of gas was less, because the engines then worked under a full load. With 47 cubic feet per kilowatt, and 55 watts per 16 candle-power, one light of that power required only 2·6 cubic feet per hour; whereas a standard Argand burner required 5 cubic feet per hour. In this comparison, it was assumed that the glow-lamps and gas-burners were in good order, but under ordinary working conditions they did not maintain so high a duty.

The question of load-factor was a serious one with any type of engine, but with gas-engines the loss was much less than with steam-engines. When a gas-engine was stopped, its consumption of fuel stopped also, and there was no furnace to maintain, nor was there any water to boil at starting. At the same time, it was desirable that the gas-engine should be worked as much as possible under a full load, and in this respect the experience at Dessau was generally confirmed. A central-station was worked under trying conditions, and in the London district there was only a full output of current during from three to five hours in every twenty-four; moreover, about 60 per cent. of the total output was required during that short period. In practice, this meant that in a station where the current was supplied without accumulators, the engines were run at a reduced speed during a portion of the time, and at other times some of them were stopped altogether; but all had to be ready to work in the evening, and occasionally in the day-time, when there was fog. Generally, it might be assumed that the average consumption was more than 6 pounds per kilowatt where accumulators were used, and about 9 to 12 pounds where they were not used. In any case, with the best possible arrangement of steam-power, there must be a large amount of fuel consumed which did no useful work; for, even if some of the fires were drawn, they had to be re-lighted, and the large quantity of water which had cooled during the time of standing must be re-heated.

The author believed that the solution of the difficulty was to be found in the use of gas-plant instead of steam-plant. With a large gas-engine, one brake horse-power per hour could be obtained with a consumption of about 1 lb. of anthracite, or 1⅓ lb. of coke; whereas the consumption of coal with the steam-engines used for central-stations, must be taken at about 2½ lbs. per brake horse-power, when working under a full load. A saving of not less than 50 per cent. could therefore be effected in stations where the engines were fully loaded; and where there were great fluctuations in the output, the loss of fuel with boilers not used, or only partly used, could be almost entirely avoided. For a maximum of 400 kilowatts, there would be three gas-generators, each capable of supplying one-third of the maximum required. The production of gas could be raised or lowered in several ways, and the working of each generator could be stopped immediately by shutting off its steam supply. Supposing, therefore, that all three generators were working at their maximum rate, and a gradual reduction was required, this could easily be effected; and when the production of one or two generators could be dispensed with their operation was at once stopped. The third generator could then be kept at work, and its production adjusted to suit the minimum consumption required. A gas-generator had a small grate-area compared with that of a boiler, and much less cooling-surface; it contained no water, and required no chimney-draught. A generator of the size referred to lost only 6 to 8 lbs. per hour whilst standing. If an average of only 40 per cent. of the maximum power were required for twenty-one hours, it was equivalent to letting two of the generators stand for that period; and at 8 lbs. each per hour that meant a total loss of only 3 cwts.; compared with the much greater waste when steam-power was used. As the use of large engines, driven with generator gas, was of recent date, the author proceeded to describe the gas-plant used, and gave the results of engines working regularly with Dowson gas, under the usual conditions obtaining in factories. He also gave the results of brake-tests made with several engines of large size, and reproduced indicator diagrams taken from engines of different makers. Although admirable results had undoubtedly been obtained from engines

working with the Otto cycle, he was of opinion, that, with engines of large size, the results would be still better if the cycle were altered, especially when generator-gas was used. His reasons for this were fully stated in the paper.

The following was a summary of the points urged by the author:—

1.—When town-gas was used for driving the engines of an electrical station, the consumption was about 50 per cent. less than the volume of gas required to give the same amount of light by ordinary burners.

2.—When town-gas was used, neither boiler nor firemen were required, and there were no ashes to remove; less space was needed; no accumulators were required, except such as might be necessary to equalize the load of the engines and to provide for a small amount of storage. The engines could be worked in the most crowded districts, close to where the lights were required, and where boilers were not allowed.

3.—When generator-gas was used, the consumption of fuel under a full load would be at least 50 per cent. less than with steam-power, and the loss due to steam-boilers not being fully worked could be almost entirely avoided.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—We regret to hear that Professor Cayley has been suffering from serious illness, and that he is in consequence unable to give this term his advertised course of lectures in Pure Mathematics.

L. Cobbett, M.A., M.B., of Trinity College, has been appointed Demonstrator of Pathology in the place of Dr. E. Lloyd Jones, who has resigned the office.

Mr. F. Darwin, Deputy Professor of Botany, announces a special course of lectures in the Chemical Physiology of Plants, to be given by Mr. Acton, of St. John's College, on Tuesdays in the present Lent Term.

Mr. J. Y. Buchanan, F.R.S., announces a second course of lectures in Geography, to be given in the Easter Term.

Mr. A. E. Shipley has been appointed an additional member of the Special Board for Biology and Geology.

SCIENTIFIC SERIALS.

Journal of the Royal Agricultural Society of England, 3rd series, vol. iii. pt. 4.—Cottage sanitation (illustrated), by H. McLean Wilson, a paper prepared under the supervision of Dr. Spottiswoode Cameron and T. Pridgin Teale, F.R.S. It contains a discussion of the principal sanitary defects, which are most likely to be found in the houses of agricultural labourers, with valuable suggestions and remedies. The object aimed at is "to put the whole country, and every house in the country, into such a condition that if the epidemic (cholera) should break out it would have no chance of spreading."—Field experiments on the fixation of free nitrogen, by James Mason, gives an account of the enriching of some plots of poor land on the Oxford clay at Eynsham by the growth of two leguminous crops in succession. The two crops chosen were beans and mixed clovers. So far as they go the results are striking. Prior to 1888 the land had never been cultivated or received any manure. Brought into tillage in that year two plots produced 10½ cwts. and 9 cwts. per acre of barley and oats respectively, straw included,—an excessively low return. In the autumn of 1888 the plots were treated with 20 cwts. of basic slag per acre, and the subsoil with the same amount. Beans in the following year yielded an average of 46 bushels and 23 cwts. straw per acre. In 1890 mixed clovers gave a yield of 28 cwts. per acre as the average of the two plots, and in 1891 a crop of three tons clover-hay was obtained. Potatoes were grown upon the plots last year, and gave an average yield of eight tons per acre. Excepting the basic slag, no manure of any kind had ever been applied to the plots. The experiments are being continued and extended.—Wild birds, useful and injurious (illustrated), by C. F. Archibald.—Utilization of straw as food for stock, by Joseph Darby. Showing methods of using chaffed straw as a remedy for the deficient hay crop of last summer, with records of previous experiences under similar circumstances.—Yew poisoning, by Mr. E. P. Squarey, Mr. Charles Whitehead, Mr. W. Carruthers, F.R.S., and Dr. Munro. But few definite conclusions can be arrived at, owing to the conflicting nature of the information available. It appears, however, (1) that both the male and female yews are poisonous; (2) the poisonous alkaloid (or alkaloids) exists chiefly in the leaves and in the seeds; (3) the fleshy part of the fruit is harmless, or nearly so; (4) the amount of poisonous alkaloid in the leaves varies considerably with individual trees, and perhaps with the season of the year. Dr. Munro contributes a review of the chemical work done upon taxine, the only alkaloid in yew which has been investigated; very little is known with certainty about it, either as to its chemical nature or its physiological action. As Dr. Munro suggests, "yew leaves merit *exhaustive* chemical examination." —Besides the official reports, there are several short articles, including one upon the ferments of milk, abridged by Dr. Munro from Prof. H. W. Conn's pamphlet on the subject, issued last summer; also a paper upon the decline of wheat-growing in England, by the editor.

American Journal of Science, January.—The age of the earth, by Clarence King. This paper contains an application of Lord Kelvin's reasoning from probable rates of refrigeration to the determination of the earth's age, aided by Dr. Carl Barus's recent work in geological physics, especially his determination of the latent heat of fusion, specific heats melted and solid, and the volume expansion between the melted and solid state, of the rock diabase. Thermal considerations have shown that with a given initial excess of temperature of the earth over surrounding space, and an assigned value for rock conductivity, it is possible to determine the curve of temperature from the earth's centre to its surface. It appears that for an initial temperature of 2000° C., the initial maximum temperature must still extend uniformly from the centre to within a few hundred miles of the surface for any admissible value of the age. But since the pressures increase steadily as we proceed towards the centre, there must be a point at which their effect outweighs that of the temperature, and the material, though very hot, remains in the solid state. Now on the data supplied by Barus's researches it is possible to state what temperatures are necessary to keep a certain representative species of rock in the fluid state at successive points within the earth. The amount of possible liquid layer is limited by the facts of tidal rigidity, which fix the maximum admissible temperature at 1950° and the age at 24×10^6 years. Lower values are excluded by the gradient of temperature observed on proceeding downwards from the surface. This value, twenty-four million years, agrees fairly well with the age assigned by Helmholtz and Kelvin to the sun. It is also concluded that the earth never was all liquid, that the original liquid layer did not exceed 53 miles, and that the spheroidal shape is due to the plasticity of the lithosphere as manifested under the action of very slowly applied forces.—Tertiary geology of Calvert Cliffs, Maryland, by Gilbert D. Harris.—"Anglesite" associated with boleite, by F. A. Genth.—Preliminary account of the iced-bar base apparatus of the United States Coast and Geodetic Survey, by R. S. Woodward.—Some experiments with an artificial geyser, by J. C. Graham.—Observations of the Andromed meteors of November 23 and 27, 1892, by H. A. Newton.—Preliminary notice of a meteoric stone seen to fall at Bath, South Dakota, by A. E. Foote.—New Cretaceous bird allied to Hesperornis, by O. C. Marsh.—Skull and brain of Claosaurus, by O. C. Marsh.

The *Botanical Gazette* for October contains an interesting article by Mr. H. L. Russell on the bacterial investigation of the sea and its floor. The author has had the opportunity of carrying on bacteriological observations in sea-water, both from the Bay of Naples and from the coast of Massachusetts. He finds micro-organisms invariably present in sea water, though not in such large numbers as in fresh water, even at a great distance from the shore, and to a depth of 3200 feet; and a larger number in the slime at the bottom than in the water itself. Some marine forms are cosmopolitan, and the bacteria that are so universally present in sea-water and mud seem to be quite peculiar to this habitat.—Mr. E. L. Berthoud describes the mode in which the geographical distribution of some plants has been greatly extended by the agency of the buffalo.—In the number for November Prof. Underwood gives a report of the proceedings of the International Botanical Congress lately held at Genoa.—Mr. G. W. Martin contributes an account of the development of the flower and embryo-sac in *Solidago* and *Aster*.

Bulletin of the New York Mathematical Society, vol. ii. No. 2, November 1892.—This number practically consists of one paper, and that a very interesting one, by Dr. Emory McClintock, "On the Non-Euclidian Geometry," a subject which has been more than once brought before our readers. In vol. viii. (1873) appeared Clifford's translation of Riemann's Habilitationsschrift "ueber die Hypothesen welche der Geometrie zu Grunde liegen" (1854). In 1883 this geometry was considered in Cayley's British Association address, and quite recently (February 25, 1892) in a translation of Poincaré's "Revue Generale des Sciences." "The chief lesson to be obtained from all non-euclidian diversions is that the distinguishing mark of euclidian geometry is fixity of distance-measurement, by which alone it is possible to draw the same figure upon different scales. That the same figure may be drawn upon different scales might well be laid down as the axiom necessary and sufficient to distinguish euclidian from non-euclidian geometry." To this is appended a footnote which says that this is "referred to as 'the axiom of similars' by Sir *Richard* (sic) Ball in the article 'Measurement' of the "Encycl. Brit." A short article follows on the new logarithmic tables of J. de Mendizábal-Tamborrel (Paris, Hermann, 1891). In addition there are the usual "Notes," but no list of publications.

No. 3, December 1892.—This number contains a careful criticism of Ball's "Mathematical Recreations," with suggestions and discussions by Prof J. E. Oliver of Ithaca, New York, and an account of Dr. Julius Bauschinger's "Zweites Münchener Sternverzeichniss, enthaltend die mittleren Oerter von 18,200 Sternen für das Aequinoctium, 1880," by Prof. T. H. Safford. "Notes" and "New Publications" follow.

Wiedemann's Annalen der Physik und Chemie, No. 12.—On the temperature coefficient of the electrical resistance of mercury and on the mercury resistances of the Imperial Institution, by D. Kreichgauer and W. Jaeger. The coefficient was measured in the case of the copies of standard resistances already described. The formula obtained for the resistance w_t at temperature t by two independent methods was

$$w_t = w_o \ (1 + 0{\cdot}000875t + 0{\cdot}00000125t^2)$$

—Generation of electricity by friction of gases against metals, by K. Wesendonck.—On galvanic polarization at small electrodes, by F. Richarz.—Electric oscillations in wires, direct measurement of the moving wave, by Kr. Birkeland. The oscillations were produced in two copper wires running parallel to each other at a distance of 80cm. They were 30m. long, and ended in one direction in brass plates 40cm. square, facing two similar plates connected with the terminals of the spark gap of a powerful induction coil. The potentials along the wire when the coil was working were determined by measuring the length of the sparks crossing between the knobs of a spark micrometer, one of them being connected with the wire by a sliding contact, the other leading through a telephone to earth. Statical effects on the telephone were made inappreciable by laying a thread moistened with dilute sulphuric acid across the wires near the "collector" plates. Under these circumstances the passage of sparks was immediately indicated by the telephone, and their length could be measured down to 0·0005mm.—Determination of dielectric constants by means of the differential inductor, by Oscar Werner.—Measurement of resistances by means of the telephone, by Max Wien.—Diffusion of light by rough surfaces, by Christian Wiener. Experiments made on cast gypsum show that Lambert's law of diffusion, according to which the brightness of a surface is independent of the angle from which it is seen, is not strictly correct. The brightness at the edge of a round surface is 0·6 times that given by his law. In the vicinity of reflection points the brightness is greater, and at the greatest brightness the angle of incidence is greater than the angle of reflection.—A unit for measuring intensity of sensation, by the same.—On internal friction of solid bodies, especially metals, by W. Voigt.—Measurement of the coefficient of diffusion of liquids, by F. Niemoeller.—Absolute compressibility of mercury, by G de Metz.—Propagation of energy through the ether, by G. Helm.—On the utilization and action of the telephone in electrical null methods; reply to Hr. Winkelmann, by E. Cohn.—On the solution of sodium silicates, and influence of time upon their constitution, by F. Kohlrausch.—Behaviour of polarized light in refraction, by G. Quincke.—On a mercury arc light, by L. Arons.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Meteorological Society, December 21.—C. Theodore Williams, President, in the chair.—The following papers were read:—Moving anticyclones in the Southern Hemisphere, by Mr. H. C. Russell, F.R.S., Government Astronomer, New South Wales. The author describes the results of his practical study of the daily weather charts for Australasia, and states that the leading fact brought out is that the weather south of 20° S. latitude is the product of a series of rapidly moving anticyclones, which follow one another with remarkable regularity, and are the great controlling force in determining local weather. These anticyclones are more numerous in summer than in winter, the average number for the year being 42. They usually take seven or eight days to travel across Australia in summer, and nine or ten days in winter; the average daily rate of translation being 400 miles. The shape of the anticyclone appears to undergo some modification as it nears the east coast. The winds on the north side of the anti-cyclone are not so strong as those on the south side, and the intensity of the weather is in proportion to the difference in pressure between the anticyclone and the V-depression, but the relation of the pressures varies frequently before the wind responds, the pressure appearing to be controlled from above by the more or less rapid descent of air which feeds the anticyclone. Cyclonic storms are very unusual, and do not occur more than once in two or three months.—The tracks of ocean wind systems in transit over Australasia, by Capt. M. W. C. Hepworth. The author has examined the daily weather charts of Australia and New Zealand, and has prepared maps showing the daily positions of the centres of high and low pressures for a whole year. He finds that the wind systems, which make their first appearance to the westward and south-westward, advance to the eastward rapidly, and frequently very rapidly, during the winter months, but during the summer months they usually move more slowly, and not unfrequently recurve. Their progress is retarded by contact with the areas of high pressure which they encounter; the mean of the tracks of these anticyclones, moving also from west to east, appears to be across the southern portion of Australia and onward, crossing the islands of New Zealand during the winter months, but to the southward of Western and South Australia, across Victoria and New South Wales, and thence to the north-eastward, avoiding New Zealand during the summer months.—Rainfall of Nottinghamshire, 1861–90, by Mr. H. Mellish. The author has collected and discussed all the rainfall records made in the county during the thirty years, and finds that in the extreme west the mean rainfall is 27 inches or more, and that over the rest of the county it varies between 25 and 27 inches, except north of the Manchester, Sheffield and Lincolnshire Railway, where the rainfall is less than 25 inches, and in the north-east towards Gainsborough, where it is not more than 23 inches. The year of greatest rainfall was 1872, and of least rainfall 1887. October is the wettest month and February the driest.—A new instrument for cloud measurements, by Dr. Nils Ekholm.

Geological Society, December 21, 1892.—Prof. J. W. Judd, F.R.S., Vice-President, in the chair.—The following communications were read:—On a Sauropodous Dinosaurian vertebra from the Wealden of Hastings, by R. Lydekker. In addition to *Hoplosaurus armatus* and *Pelorosaurus Conybearei*, there is evidence of another large Sauropodous Dinosaur in the Wealden, now known as *Morosaurus brevis*. Up to the present time it has been impossible adequately to compare *Hoplosaurus armatus* with *Morosaurus brevis*; but recently Mr. Rufford has sent to the British Museum an imperfect dorsal vertebra of a large Sauropodous Dinosaur from the Wealden of Hastings, which enabled the required comparison to be made. The author describes the vertebra, contrasts it with that of *Hoplosaurus armatus*, and gives presumptive evidence that it should be referred to the so-called *Morosaurus Becklesi* (Marsh), which apparently cannot be separated from *M.* (*Cetiosaurus*) *brevis*. He has not been able to compare Mr. Rufford's specimen with the dorsals of the American *Morosaurus*, in order to discover whether the English Dinosaur is correctly referred to that genus. This paper led to a discussion, in which the chairman, Mr. Hulke, Prof. Seeley, Mr. E. T. Newton, and the author took part.—On some additional remains of Cestraciont and other fishes in the Green Gritty Marls, immediately overlying the Red Marls of the Upper Keuper in Warwickshire, by the Rev. P.

B. Brodie. The vertebrate remains occur in a very thin band of marly friable sandstone lying between two beds of green marl, though in some places the same bed has itself no admixture of sandy material. Bones and teeth are so numerous that it might almost be called a bone-bed. It does not exceed three inches in thickness. It contains ichthyodorulites of Cestraciont fishes, abundant palatal teeth of *Acrodus keuperinus*, ganoid fish-scales, and abundant broken bones, some of which may belong to fishes, others to labyrinthodonts, and amongst the latter a fragment of a cranial bone. The Chairman congratulated the Society on the presence of one of its Fellows who had been connected with it for nearly sixty years, and had read his first paper almost half a century ago. He hoped that the Society would still continue to receive communications from the same source of like interest and value. Mr. J. W. Davis, Mr. H. B. Woodward, and Mr. E. T. Newton also spoke.—*Calamostachys Binneyana*, Schimp, by Thomas Hick. Communicated by J. W. Davis.—Notes on some Pennsylvanian calamities, by W. S. Gresley. — Scandinavian Boulders at Cromer, by Herr Victor Madsen, of the Danish Geological Survey. Communicated by J. W. Hulke, F.R.S. During a visit to Cromer in 1891 the author devoted much attention to a search for Scandinavian boulders, and obtained three specimens; one (a violet felspar-porphyry) was from the shore, and the other two were from the collection of Mr. Savin. The first was considered to come from south-east Norway, and indeed Mr. K. O. Björlykke, to whom it was submitted, refers it to the environs of Christiania. The author considered that the two specimens presented to him by Mr. Savin, who had taken them out of Boulder Clay between Cromer and Overstrand, were from Dalecarlia; and these were submitted to Mr. E. Svedmark, who compared one of them (a brown felspar-hornblende-porphyry) with the Grönklitt porphyry in the parish of Orsa, and declared that the other (a blackish felsite-porphyry) might also be from Dalecarlia. This paper was discussed by Mr. C. Reid, Mr. J. W. Davis, the Rev. P. B. Brodie, Dr. Hicks, Mr. Marr, and the Chairman.

EDINBURGH.

Royal Society, December 19, 1892.—Sir Douglas Maclagan, President, in the chair.—Dr. Hunter Stewart read a paper on an extension of Kjeldahl's method of organic analysis, and described an apparatus which he had devised for the estimation of the amount of organic carbon present in water.—Prof. Rutherford read a note by Dr. W. G. Aitchison Robertson on the madder-staining of dentine. Rabbits were fed on madder for some time and were then killed, the dentine being then found to be stained. When other food was supplied for a time, the process of feeding on madder being resumed afterwards, two coloured layers were found in the dentine, with an intermediate colourless layer.—Prof. C. G. Knott read a paper on recent innovations in vector theory. He entered into a critical examination of the anti-quaternionic attitudes taken up by Prof. Willard Gibbs, Mr. Oliver Heaviside, Prof. Macfarlane, and others. His chief arguments were (1) that the quaternion was as fundamental a geometric conception as either its scalar or its vector part—indeed more fundamental; (2) that in the development of his dyadic notation, Prof. Gibbs, being forced to bring the quaternion in, logically condemned his own position; (3) that a really flexible vector analysis must be versorial, the equations $ij = k$, $jk = i$, $ki = j$, &c., being from the geometrical and physical point of view essentially rotational; (4) that the non-associative character of the vector-analysis, in which i^2, j^2, k^2, were *assumed* to be $+ 1$, rendered it totally unfit for higher physical research; (5) that this tinkering with the algebraic sign quite spoiled the real efficiency of the very beautiful quaternion operator ∇—Prof. Gibbs, for example, being compelled to introduce the (supposed) new functions of operation Pot, New, Lap, Max, which in quaternions are the very simplest of inverse functions of ∇, and are best expressed as such.

DUBLIN.

Royal Dublin Society, December 21, 1892.—Prof. A. C. Haddon in the chair.—Prof. Sollas, F.R.S., read a paper on pitchstone and andesite from tertiary dykes in Donegal. The author found that a microscopical examination of some remarkably fresh glassy rocks from Donegal revealed a close resemblance between them and rocks of the same age in Arran. This helps to confirm the supposed great extension of tertiary dykes through the north-west of Ireland. Prof. Sollas next read a paper on the variolite and associated igneous rocks of Roundwood, co. Wicklow. He described them as a complex of basic rocks, including altered ophitic dolerite, spilite (variolite du Drac), and spherulitic tachylite (variolite de la Durance). In connection with the epidotisation of the rock the author pointed to the excessive fissuring which it has undergone; and showed that the formation of epidote is attended with considerable diminution of volume, sufficient to account for the cracks. The formation of serpentine and chlorite is attended with expansion, and chlorite can scarcely be formed without the simultaneous liberation of a disproportionately large percentage of quartz. This explains the common association of chlorite with the quartz of quartz veins.—Sir Howard Grubb, F.R.S., described a new system of mounting for monster reflecting telescopes.—Mr. H. H. Dixon read a paper on the germination of seedlings in the absence of bacteria. Seeds, the outer coats of which were sterilized, germinated in the absence of bacteria, and being kept absolutely free from bacteria did not, after growth had ceased, suffer the decay of death, but remained for more than twenty months apparently unchanged. An apparatus for sterilising the outer coats of the seeds and sowing them without the introduction of bacteria was also described.—A paper was communicated by Prof. A. C. Haddon, and Miss A. M. Shackleton, describing some new species of Actiniæ from Torres Straits.

BERLIN.

Meteorological Society, December 6.—Dr. Vettin, President, in the chair.—Prof. Assmann gave a detailed description of the meteorographs set up in the "Urania-pillars." Each pillar contains a thermograph, a barograph, and a hygrograph, placed side by side in a metal case through which a rapid current of air is kept up. The thermograph consists of a Bourdon spring, filled with alcohol, whose movements are communicated to an external recording-lever. The barograph is made of four boxes joined together, and delicately balanced by a weight, whose movements are similarly recorded externally. The hygrograph consists of a bundle of hairs 2 m. in length. The above instruments have continued to work well after several months' use. Their chief defect is due to the hygroscopic properties of the paper on which the three levers trace their record. The large amount of material in the shape of meteorograms already collected has revealed a number of interesting facts. Thus, for instance, the temperatures recorded on two closely-adjacent pillars may differ by 1° or more not only on a warm summer day, but also during the night of November 26, the coldest of this year. In one case the air was found to be warmed by the adjacent row of houses exposed to direct sunlight. In another the radiation was observed to be greater opposite a gateway than in the street. The very considerable local differences of air-temperature recorded on closely-neighbouring pillars could scarcely have been *à priori* expected.

Physiological Society, December 9, 1892.—Prof. du Bois Reymond, President, in the chair.—Prof. Exner, of Vienna, gave a *résumé* of his researches on the innervation of the crico-thyroid muscle in rabbits and dogs. In each he had found a branch from the pharyngeal branch of the vagus distributed to this muscle, together with the superior laryngeal nerve, to which he has given the name of median laryngeal nerve. The communication was illustrated by an experimental demonstration.—Dr. Hansemann stated that he had obtained photographs of microscopic objects. which when placed in a stereoscope, presented an appearance of solidity. They were produced by taking one photograph of the object in focus for a given level, and then a second photograph at a different level. These photographs united stereoscopically gave the impression of solidity.—Prof. Hilgard drew attention to the remarkable fact that the most civilized races of antiquity usually established themselves in dry districts. This he attributed to the fact, borne out by numerous analyses of soils in America, that in dry regions the earth is far richer in mineral food-stuffs necessary to plant life than in wet regions where these are largely washed out of the soil. Hence in dry regions simple irrigation suffices to produce a luxuriant vegetable growth, while on the other hand the soil of moist regions is very rapidly exhausted.

PARIS.

Academy of Sciences, January 9.—M. de Lacaze-Duthiers in the chair.—Drainage waters of cultivated lands, by M. P. P. Dehérain. An experimental investigation of the substances found in water drained from various cultivations showed that all the waters contained a fair proportion of nitrates. Even beetroot, which not only utilizes nitrogen for the formation of its

albuminoids, but also stores nitrates in its tissues, gave 31, 39, and 95 gr. of nitric acid per cubic metre of drainage water. Beetroot gives, however, the least quantity of nitrogen in the drained water in proportion to the crop. Next comes Turkey corn, and then potatoes. It appears certain that all nitrogen which enters the soil is either assimilated or else lost. In the case of a bad harvest there is a loss both from the poverty of the crop and the impoverished state of the soil.—On the small planets and nebulæ discovered at the Nice Observatory by MM. Charlois and Javelle, and at the Mounier observing station, by M. Perrotin. A list of eight minor planets discovered by the photographic method in four weeks, *i.e.* one-sixteenth of the time necessary to achieve the same result by eye observation.—Dilatation and compressibility of water, by E. H. Amagat. Tables are given showing the relative volumes of a quantity of water at pressures varying from 1 to 3000 atmospheres and temperatures ranging from 0° to 198°; and others showing the compressibility of water under the same conditions. This is seen to vary inversely as the pressure, and also inversely as the temperature up to very high pressures, when it begins to increase with the temperature.—Observations of Brooks's comet (November 19, 1892), made at the Paris Observatory (west equatorial), by M. O. Callandreau.—Observations of solar phenomena, made at the observatory of the Roman College during the third quarter of 1892, by M. P. Tacchini.—On the reduction of elliptic integrals, by M. J. C. Kluyver.—On the thermal variation of the electric resistance of mercury, by M. Ch. Ed. Guillaume. Pointing out the remarkable agreement of his results with those obtained by Messrs. Kreichgauer and Jäger, at the Physico-Technical Institute of Germany (see *Wiedemann's Annalen*, No. 12).—On the measurement of power in multiphase currents, by M. Blondel.—Absolute value of the magnetic elements on January 1, 1893. The elements for that date, determined at the magnetic observatory of the Parc Saint-Maur, situated in long. 0° 9′ 23″ E. and lat. 48° 48′ 34″ N., are the following:—

	Absolute values on January 1, 1893.	Secular variation in 1892.
	° ′	′
Declination	15 24·3	− 6·4
Inclination	65 8·5	− 0·5
Horizontal force	0·19596	+ 0·00016
Vertical force	0·42297	+ 0·00019
Total force	0·46616	+ 0·00024

The values for the magnetic and meteorological observatory of Perpignan, long. 0° 32′ 45″ E., lat. 42° 42′ 8″ N., are

	Absolute values on January 1, 1893.	Secular variation in 1892.
	° ′	′
Declination	14 12·9	− 5·9
Inclination	60 13·3	− 1·8
Horizontal force	0·22278	+ 0·00030
Vertical force	0·38933	+ 0·00003
Total force	0·44856	+ 0·00017

—On the purification of arsenical zinc, by M. H. Lescoeur. Zinc destined for toxicological operations can be obtained free from arsenic, antimony, sulphur, and phosphorus by two successive operations, viz. oxidation by means of nitre, and fusion with chloride of zinc.—Combinations of quinoleine with the halogen salts of silver, by M. Raoul Varet.—Symmetric dipropylurea and dipropylsulphourea, by M. F. Chancel.—On a substance derived from chloral, or chloralose, and its physiological and therapeutic effects, by MM. Hanriot and Ch. Richet.—On phagocytosis observed on the living animal, in the branchii of the lamellibranch molluscs, by M. de Bruyne.—New observations on the affinities of the different groups of gasteropods, by M. E. L. Bouvier.—On an anomaly recently presented by the secular variation of the magnetic needle, by M. Léon Descroix.—Influence of motion on the development of fowls' eggs, by M. A. Marcacci.

AMSTERDAM.

Royal Academy of Sciences, December 24, 1892.—Prof. Van de Sande Bakhuysen in the chair.—In a paper read by MM. S. Hoogewerff and W. A. van Dorp, some isoimides of camphoric acid were described. These were obtained by the action of $POCl_3$ or $CH_3.COCl$ on some substituted camphoramic acids. The following reaction takes place:—

$$C_8H_{14}\left\langle\begin{matrix}CO.NHR\\COOH\end{matrix}\right. + CH_3.COCl = C_8H_{14}\left\langle\begin{matrix}C=NR\\C=O\end{matrix}\right\rangle O + HCl + CH_3COOH$$

where R is put for CH_3, C_2H_5 or C_7H_7. The isoimides are very unstable; they easily add one molecule of water, re-generating the acids from which they derive. By the action of heat they are transformed into the ordinary imides $C_8H_{14}\begin{matrix}-CO\\-CO\end{matrix}\rangle NR$.—The same authors called attention to the fact that it seems to be a general reaction of the anhydrides of bibasic acids to dissolve in the aqueous solutions of ammonia and the primary amines, forming the corresponding acid amides: $R\left\langle\begin{matrix}CO\\CO\end{matrix}\right\rangle O + NH_2.R_1 = R\left\langle\begin{matrix}CO.NHR_1\\COOH\end{matrix}\right.$.—Mr. Bakhuis Roozeboom dealt with the solubility-curve for systems of two bodies. The general form of such a curve in its totality, as yet not known even by the researches of Engel, has been encountered by the author and Mr. Schreinemakers in studying the solubility of $Fe_2Cl_6.12H_2O$ in solutions of HCl. The curve is a continuous one, combining the two solubilities of the hydrate, recently made known by the author. It presents a summit when the proportion of Fe_2Clf is the same as in the solid hydrate. Part of the solutions give on water-additions a deposit of the hydrate, part of them give redissolution. The general form of the curve for double salts would be represented in its totality by a closed curve, surrounding the point, indicating the composition of the double salt. With this form the same division of the solutions in regard to their behaviour on water-addition is possible as above.—Prof. Lorentz treated of Stokes's theory of the aberration of light. The hypothesis of M. Stokes, that the movement of the ether admits of a velocity-potential, is in contradiction with the supposition that, at the surface of the earth, the velocity of the ether is equal to that of the planet. It might, however, be doubted whether, in M. Stokes's explanation, the first hypothesis is really necessary. In the present note it is shown that it cannot be avoided.

CONTENTS.

THURSDAY, JANUARY 26, 1893.

MODERN ADVANCED ANALYSIS.

Theory of Numbers. By G. B. Mathews, M.A. Part I. (Cambridge: Deighton, Bell and Co., 1892.)

THE book under review is a great contrast in many ways to the "Théorie des Nombres" of M. Edouard Lucas, the first volume of which has recently appeared under the ægis of Messrs. Gauthier-Villars. The latter, reminding the reader much of the same author's "Récréations Mathématiques," exhales human interest from well-nigh every page. The former is on severe philosophical lines, and may be greeted as the first work of the kind in the English language. That this should be a fact is somewhat remarkable. When the late Prof. H. J. S. Smith died prematurely many years ago he left his fellow-countrymen a very valuable legacy. Fortunately he had been commissioned by the British Association to frame a report on the then present state of the Theory of Numbers, a subject with which he was pre-eminently familiar, and in which his own original researches had won for him a great and world-wide renown. The pages of the reports for the years 1864–66 inclusive yield as a consequence a delightful account of modern research in this recondite subject. It is, however, much more than a recital of victories achieved by many able men in many special fields. Prof. Smith's fertile genius enabled him to marshal the leading facts of the theory, and to impress upon them his own personality in a manner that was scarcely within the reach of any other man. He contrived to impart a glamour to those abstract depths of the subject to which few mathematicians have sufficient faith and energy to penetrate. Since that day the scientific world has been yearly expecting his collected papers. There is no doubt that their appearance will greatly stimulate interest and research in Higher Arithmetic. The reports of the British Association are not sufficiently accessible. Doubtless the papers will soon emerge from the hands of those upon whom has devolved the responsibility of their production. In the meantime we welcome Part I. of the present work.

The theory of numbers is the oldest of the mathematical sciences, and may be regarded as their sire. Just as applied mathematics is based on pure, so pure mathematics rests on the theory of numbers. Every investigator finds that sooner or later his researches become a question of pure number. Continuous and discontinuous quantity are indissolubly allied. The theory of series, the theory of invariants, the theory of elliptic functions throw light upon and receive light from higher arithmetic. Algebra in its most general sense is everywhere pervaded by numbers. It may safely be affirmed that there is nothing more beautiful or fascinating in the wide range of mathematics than the interchange of theorem between arithmetic and algebra. A proposition in arithmetic is written out as a theorem in continuous quantity or conversely an algebraic identity is represented by a statement concerning discontinuous quantity. In this country the more recent advances in this attractive method are in large measure due to the labours of Sylvester and J. W. L. Glaisher. In a "Constructive Theory of Partitions," published some half-dozen years ago in the *American Journal of Mathematics*, Sylvester showed some beautiful progressions from arithmetic to algebra, and was followed in the same line by Franklin, Ely, and others, whilst in the pages of the *Quarterly Journal of Mathematics* and *Messenger of Mathematics* Glaisher has applied elliptic function formulas to arithmetical theory. The famous theorem which asserts that every number can be composed by four or fewer square numbers, was due to an application by H. J. S. Smith of elliptic functions to arithmetic. These interesting matters are not alluded to in this first volume.

Chapter I. discusses the divisibility of numbers and the elementary theory of congruencies. Euler's function $\phi(n)$, which denotes the number of positive integers, unity included, which are prime to and not greater than n, is not treated as fully as might be desired. Gauss's theorem

$$\phi(d) + \phi(d') + \phi(d'') + \dots = n$$

where $d, d', d'', \dots$ are all the divisions of n (unity and n included) is given, but not some interesting theorems connected with permutations, of which this is a particular case. Sylvester has written much about the same function, which he calls the "totient" of n. M. Ed. Lucas employs the term "indicateur" in the same sense, and believing that there is a great convenience in having a special name for the function, we regret that Mr. Mathews has not taken a course which would have familiarized students with Sylvester's nomenclature, and have enabled them to feel at home with much that has been written by him and others in this part of the theory of numbers.

The author states that this chapter is substantially a paraphrase of the first three sections of the "Disquisitiones Arithmeticæ," the classical work of Gauss; we are inclined to think that advantage would have been gained if the paraphrase had not been quite so close. The next succeeding chapters are occupied with "Quadratic Congruencies" and the theory of "Binary Quadratic Forms."

The account given is fairly complete. There are so many proofs of Legendre's celebrated "Law of Quadratic Reciprocity" that it must have been difficult to make a selection. A wise choice has, we think, been made of Gauss's third proof as modified by Dirichlet and Eisenstein; the latter's geometrical contribution to the proof taken from the twenty-seventh volume of Crelle is, in particular, of great elegance. Gauss's first proof is also given, as well as references to several others. In the difficult subject of Binary Quadratic Forms, the author keeps well in view the close analogy with the algebraic theory of forms; so many additional restrictions present themselves that a large number of definitions are requisite at the outset, and this circumstance is apt to repel a student who approaches the theory for the first time. The definitions, in fact, constitute the alphabet of the science which must be mastered before progress can be expected in the appreciation of the wonderful beauties which are inherent in it. In this subject, more almost than in any other, the initial drudgery must not be shirked, and it may be said in favour of the present work that clearness of definition and conciseness of statement help the learner much to get quickly over the wearisome preliminaries.

 O

We are glad to see the prominence given to the geometrical methods of Klein and Poincaré; that of the former is based on the theory of substitutions, reminding the reader much of the "Icosaeder"; that of the latter s the "Method of Nets," a most ingenious geometrical application throwing light on the theory of "Reduced Forms."

The "Composition of Forms" given in Chapter VI. is logically and judiciously developed, by means of the bilinear substitution, up to the point of showing the method of tabulating the primitive classes of regular and irregular determinants. The chapter on cyclotomy is one of the best written in the book. The discussion of the section of the periods of the roots of unity has engaged the attentions of mathematicians of the first rank since the time of Gauss, so that of necessity much has been written, and while the author states that he has given but an outline of an extensive theory which has not yet been completed, it may be said that the theory as given, with the references to authorities at the end of the chapter, will be quite sufficient to conduct the student bent upon research to the frontiers of the unknown country.

The determination of the number of properly primitive classes for a given determinant, applications of the theory of quadratic forms, and the distribution of primes complete the volume. Mr. Mathews may be congratulated on his resolve to include Sylvester's masterly contraction of Tchébicheff's limits with reference to the distribution of primes; the reader is taken from the "sieve" of Eratosthenes to the work of Legendre, Meissel, Rogel, Riemann, and to the latest researches of Sylvester and Poincaré, of which the ink is scarcely dry. English mathematicians will turn with delight to the account given on page 302 of Riemann's great memoir of 1859, which contains the only satisfactory attempt to obtain an analytical formula for the number of primes not exceeding a given numerical quantity.

In conclusion, though the sequence of the subject matter may be open to criticism, we regard the book as a most valuable contribution to the small library of higher mathematical treatises that, owing chiefly to the energy and enthusiasm of the rising generation of mathematicians, is being brought together. How woefully deficient that library was but a few years since those engaged in research know only too well, and greatly do they rejoice as they see the yawning gaps one by one efficiently filled up. Part II. of the task Mr. Mathews has set himself to accomplish will, we hope, soon appear, and we trust he will be as successful with it as with the present Part I. P. A. M.

THE DARWINIAN THEORY.

Darwin and After Darwin; an Examination of the Darwinian Theory and a Discussion of Post-Darwinian Questions. By George John Romanes, M.A., LL.D., F.R.S. I. *The Darwinian Theory.* (London: Longmans, 1892.)

WE had hoped ere now to have received the second instalment of this work, and to have dealt with the two volumes in a single critical notice. Unforeseen causes, one of them deeply to be regretted, have presumably prevented the appearance of the discussion of Post-Darwinian questions so early as had been anticipated. We therefore propose to give a short expository notice of the present volume, reserving such criticism as we have to offer for a future occasion, when the second volume shall have come to hand.

The first section consists of an exposition of the scientific evidences of evolution as a fact independent of the Darwinian theory of the method by which this evolution has been brought about. It may be regarded as an expansion of the author's little volume in the "Nature Series," on "The Scientific Evidences of Organic Evolution," published ten years ago. Mr. Romanes has spared no pains in the collection and marshalling of his evidence. His object is to convince, by the abundance of facts and by logical inferences based thereon, those who still hold by the tenets of Special Creation. Whether those who still hold by these tenets are likely to be influenced by the facts or the inferences is a question we do not propose to discuss. The author evidently supposes that they are, and has written for them a good many pages in a strain of which we give a couple of examples:—"It would seem most capricious on the part of the Deity to have made the eyes of an innumerable number of fish on exactly the same ideal type, and then to have made the eye of the octopus so exactly like these other eyes, in superficial appearance, as to deceive so accomplished a naturalist as Mr. Mivart, and yet to have taken scrupulous care that in no one ideal particular should the one type resemble the other." Again, "Although in nearly all the numerous species of snakes there are no vestiges of limbs, in the Python we find very tiny rudiments of hind-limbs. Now, is it a worthy conception of Deity that, while neglecting to maintain his unity of ideal in the case of nearly all the numerous species of snakes, he should have added a tiny rudiment in the case of the Python—and even in that case should have maintained his ideal very inefficiently, inasmuch as only two limbs, instead of four, are represented?"

The second section of the volume is devoted to the setting forth of the theory of natural selection as it was held by the master. This, as was to be expected, is a well-ordered and lucid exposition. We could wish that Mr. Romanes had been more careful to avoid all appearance of personifying natural selection. He says, for example, "it is the business of natural selection to secure the highest available degree of adaptation for the time being." Such language is highly metaphorical, if not misleading. If we can talk of business at all we may say that it is the business of various eliminating agencies, in the struggle for existence, to weed out and exclude from any share in perpetuating their race all those individuals who are too weakly to stand the stress of the struggle. The survival of the fit is an incidental result of the stern business of elimination. It is here that the naturalistic hypothesis differs most markedly from the teleological interpretation of nature. In conversation a while since a friend observed to us: Since your school of thought admit that the eye of natural selection is ever on the watch for the slightest improvement in adaptation, why should they hesitate to say with us that it is the eye of Beneficence that is thus ever watchful? The misunderstanding of the naturalistic position here

shown is not surprising. It is due to the too free use of metaphorical language on the part of expounders of the Darwinian hypothesis.

In the chapter entitled "Criticisms of the Theory of Natural Selection," an interesting digest is given of the work of Prof. Ewart and others on the electric organ of the skate, concerning which Mr. Romanes says, "I freely confess that the difficulty presented by this case appears to me of a magnitude and importance altogether unequalled by that of any other single case—or any series of cases—which have hitherto been encountered by the theory of natural selection." And he adds, "So that, if there were many other cases of the like kind to be met with in nature, I should myself at once allow that the theory of natural selection would have to be discarded," by which he means, we presume, that the theory would have to be discarded as offering a solution of such cases.

The book contains many excellent illustrations, the series which show the variations due to artificial selection being a noteworthy feature. They, and the volume which contains them, will prove of service to those general readers for whom, as the author tells us in his preface, this exposition of the Darwinian theory has been mainly prepared.

FERNS OF SOUTH AFRICA.

The Ferns of South Africa, containing Descriptions and Figures of the Ferns and Fern-allies of South Africa. By Thomas R. Sim. 275 pp., 159 plates. (Cape Town and Johannesberg: J. C. Juta and Co. London: Wm. Wesley and Son, 1892.)

THE present work will be a useful and acceptable addition to our stock of fern-books. It contains descriptions and plates of all the ferns and fern-allies known to exist in Africa south of the tropic of Capricorn, the same area which is included by Harvey and Sonder in their "Flora Capensis," three volumes of which, including the orders from Ranunculaceæ to Campanulaceæ, have been published. The author won the Jubilee gold medal given by the North of Scotland Horticultural Association, and for many years has filled the post of curator of the Botanic Gardens at King William's Town. Several years ago Mr. Sim published an illustrated handbook of the ferns of Kaffraria, and now he has extended his area so as to include the whole of South Temperate Africa.

The fern flora of the Cape does not show the same richness and remarkable individuality which characterises its phanerogamic flora. It is probable that the flowering plants of this area are not less than ten thousand, and the number of large endemic genera and of species is very considerable. In ferns we get in South Africa 179 species, out of which 42 species, or something under 25 per cent., are endemic. There is no genus that is peculiar to the Cape; of Mohria, which comes nearest, the Cape species, *M. caffrorum* extends to Madagascar and Tropical Africa, and two new species have lately been found in the high regions north of the colony. The section Rhizoglossum of the genus Ophioglossum, which differs from the true adder's tongues by having the fertile spike separate from the barren frond, the single species, *O. bergianum*, is peculiar to the Cape. Hymenophyllum is represented by 8 species, Trichomanes by 5, Adiantum by 6, Cheilanthes by 8, Pellæa by 14, Pteris by 7, Lomaria by 5, Asplenium by 25, Nephrodium by 12, Polypodium by 12, Acrostichum by 8; and Lycopodium by 8 species. Some of the species, *e.g. Vittaria lineatia*, *Marattia* and the two tree-ferns, are tropical types; some, such as *Cystopteris fragilis* and *Lycopodium clavatum*, are common to Britain and the Cape. *Todea barbara* is confined to the Cape and Australia, and abundant in both areas. *Lomaria alpina* is a plant of all the three south-temperate areas. *Blechnum australe* of the Cape is not, I think, really distinct specifically from *B. hastatum*, and is widely spread in South Temperate America.

Lomaria punctulata is remarkable for its polymorphic fructification, which is sometimes like that of a Scolopendrium. *Asplenium lunulatum* is remarkable for its variability in outline and cutting.

Mr. Sim gives introductory chapters on the parts of ferns and their nomenclature, on their reproduction and propagation, on their cultivation and the preparation of herbarium specimens, and on the history of the discovery of the Cape species and the books and papers that have been written about them. His statistic table on page 34 needs much revision in some of its items. He gives the ferns of Madagascar at 144. The number now known in the island is 326 true ferns and 40 fern allies, a total of 366. There are nothing like 683 species and 458 endemic types in Africa and its islands. When I counted them up in 1868 I made the two figures 346 and 127. Since that date probably 100 species have been added. Madagascar, Bourbon, and Mauritius are very rich in ferns, but Continental Africa is very poor both in number of species and in peculiar types as compared with Asia and America.

The descriptions are carefully drawn up from the study of actual specimens, and by the aid of these and the plates there can be no difficulty for any one, even without any previous botanical knowledge, in making out the name of any reasonably complete specimen of any of the Cape species.

Therefore, no doubt, the existence of such a book will give a great impulse to the study of ferns by ladies and others who reside in or visit the Colony.

J. G. Baker.

OUR BOOK SHELF.

Newcomb-Engelmann's Populäre Astronomie, Zweite vermehrte Auflage. Herausgegeben von Dr. H. C. Vogel. (Leipzig: Wilhelm Engelmann, 1892.)

THE well-known Popular Astronomy of Prof. Newcomb was translated into German by Rudolf Engelmann, and published in 1881 with considerable additions and alterations, most of which were improvements. It was very favourably received on its first appearance in German, probably because it is not only comprehensive, exact, and scientific, but has a fresh and vigorous style, in pleasing contrast to the ponderous German standard works. The original translator being dead, the publishers entrusted the work of preparing a new edition to Dr. H. C. Vogel, Director of the Astrophysical Observatory at Potsdam, a task for which he was specially fitted, because astronomical progress during the decade since the appearance of the first edition of the book has been mainly in his special

department. Dr. Vogel's chief difficulty has been to keep the book within reasonable limits while bringing it up to date, but he has not been wholly successful in this. By a slight further enlargement of the book he might without difficulty have very much increased its value. A description of the diffraction spectroscope should have been given in the section on spectroscopes; Prof. Hale's work in photographing prominences and faculæ should have been introduced; the chapter on Mars is very much behind the times; and some details should certainly have been given of the international scheme for photographically charting the stars.

Dr. Vogel has considerably altered the arrangement of the chapter on comets and meteors, and this alteration has led to the curious result that the same woodcut appears as Figs. 152 and 165. The chapter on stellar astronomy is also recast, the editor's own latest classification of star spectra being given to the exclusion of all others. The section on variable stars has also been entirely rewritten. These chapters would have been much improved by an account of recent discoveries as to the resemblances between comets, nebulæ, and stars, and of the theory that variable stars are formed of revolving swarms of meteorites. The classification of star spectra which recognises an ascending and descending temperature should have been given, and recent work and theories on temporary stars certainly deserved attention. The bibliography given in the first edition has been omitted in the second, as being too much for the general reader, and insufficient for the student of science. The excellent series of biographical notices in the appendix has been carefully extended to 1891, and completely rearranged. Dr. Vogel has adopted the admirable plan of arranging these notices chronologically in order of death, instead of birth, probably on the grounds that all work is largely the result of previous discoveries, and that the later years of a man's life are usually his best and most productive. A series of excellent tables and a full index complete the volume.

The general appearance of the book has been much improved by the use of new woodcuts for the illustrations, and by the substitution of two excellent photographs of nebulæ (those of Orion and Andromeda) for the very unsatisfactory star charts of the earlier edition.

A. T.

The Hemiptera Heteroptera of the British Islands. By Edward Saunders, F.L.S. (London: L. Reeve and Co., 1892.)

IT is now nearly thirty years since Douglas and Scott first made the study of the British Hemiptera Heteroptera possible to ordinary students by the publication of a description of these insects in a volume issued by the Ray Society. The difficulties were then very great, for purely insular ideas in entomology were prevalent, and our hemipterous insects had not been sufficiently compared with continental species. Douglas and Scott did all that was possible at that time and produced a good work that has held the ground as the best published authority on the subject. Very much, however, has been done since that period, and restricted specialists in entomology, as in most other branches of natural science, have exercised unlimited time and patience in studying the classificatory problems of a single family or even of a large genus. Hence in a monograph of to-day the standard of advanced classification and descriptive facility is considerably raised from that which dominated the writings of the earlier authors. Mr. Saunders has not only aimed at this perfection, but has sought to place in the hands of the British student and collector a thoroughly trustworthy handbook by which he may understand and identify his collection, and in this we think the author has altogether succeeded. We must not look for bibliographical references or synonymical notes, the names of the describers of families, genera, and species being only indicated, while the habitats of the species are confined to such localities in the British Islands as are recorded by collectors; and this is perhaps all that can be expected in a local monograph. It is therefore in no spirit of criticism we express a regret that in all faunistic writings the complete recorded distribution of the species is not given. Thus even the purely British collector would not be the worse for learning that *Zicrona cærulea*, to be found in the suburbs of London, is not only widely distributed throughout the Palæarctic region, but is also found in Continental India and in the Malay Peninsula and Archipelago; or that *Ischnorhynchus resedæ*, to be taken even at Hampstead, is common throughout Europe and Siberia, and is also neither scarce in North nor in Central America.

We welcome Mr. Saunders's book as a distinct and valuable addition to our insular entomological literature. We also notice that an illustrated edition is advertised, but on the quality of the plates we are compelled to be silent, as the publishers have only forwarded us a plain copy.

W. L. D.

Physical Education. By Frederick Treves, F.R.C.S. (London: J. and A. Churchill, 1892.)

THIS essay is reprinted from the "Treatise on Hygiene" by various authors, edited by Stevenson and Murphy, the first volume of which we recently reviewed (NATURE, vol. xlvi. p. 609). It well deserves to be issued separately, for the author has mastered his subject thoroughly, and sets forth his ideas in a plain, straightforward style which will be cordially appreciated by readers who are especially interested in athletics. Mr. Treves is quite as strongly conscious of the evils which may spring from excessive or unsuitable physical exercise as of those which may result from physical exercise being neglected or underrated, so that there is a welcome tone of perfect impartiality in all he has to say about the various ways in which efforts are made to promote health by the use of the muscles. The volume may be confidently recommended to all who desire to understand the conditions under which physical exercise is most likely to be of service.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Geology of the North-west Highlands.

IN the kindly review of my work by Prof. de Lapparent, which appeared in NATURE of 5th inst., there are one or two inaccuracies which I would at once have corrected had I not shrunk from drawing attention, even for purposes of rectification, to an article which I felt to be too eulogistic. Lest, however, my silence be misinterpreted, there is one point on which I wish to say a few words. Prof. de Lapparent, when alluding to the solution of the problem of the geological structure of the North-west Highlands, makes no reference to the distinguished part taken in that subject by Prof. Lapworth. But every one who has followed the progress of geology in recent years is familiar with his work. For myself, I have had no personal share in the discovery. Like most geologists I had accepted the views of Sir Roderick Murchison, and I held to them, until, after the Geological Survey was for the first time extended to Sutherland in 1883–84, I was finally convinced that they were untenable by the brilliant mapping of my colleagues, Messrs. Peach and Horne, who, following Prof. Lapworth's lead, share with him in the glory of one of the greatest achievements of field geology in recent times. My recantation was published in NATURE of November 13, 1884, and the whole history of the investigation of the North-west Highlands up to Prof. Lapworth's latest paper

was sketched in a detailed Report communicated by me to the Geological Society on April 25, 1888. My friend Prof. Lapworth has no scientific comrade who has more frankly and practically acknowledged his great geological achievements than I have done. ARCH. GEIKIE.

January 23, 1893.

The Identity of Energy.

I AM glad to see that in the introduction to his severely-difficult memoir, published in the *Philosophical Transactions* for 1892, "On the Forces, Stresses, and Fluxes of Energy in the Electromagnetic Field" (p. 427), Mr. Oliver Heaviside notices and criticizes some ideas of mine, published in the *Philosophical Magazine* for June 1885 and other places, concerning energy.

The statements I then made, and to which I still rigidly hold, are (1) that energy has identity like matter, and not merely conservation; (2) that whenever energy is transferred from one body to another, it is also transformed from potential to kinetic, or *vice versâ*.

The basis of the first assertion is the fact that energy is always passed on continuously through space, *i.e.* that its transfer occurs along a definite path, instead of merely appearing in one place and disappearing in another.

The law of conservation would be satisfied by disappearance and equal reappearance; the law of identity requires a continuous act of transfer. The latter is true for matter, and I assert that by thinking of a number of instances, it will be perceived true for energy. In all mechanical instances, as of belts and shafting, the transfer of energy is obvious; it was not so obvious in electromagnetic actions, between dynamo and motor for instance, until Prof. Poynting clearly demonstrated that it was in accordance with Maxwell's principles.

Mr. Heaviside objects that we are not able to assert it for gravitational energy. Well, that depends on what view we take of gravitation; but I submit that until something more is certainly known about it, the safest plan is not to assert, but to assume, that in this case also what is known in every other case likewise occurs, and to trace the consequences of the hypothesis in the hope that it may lead to some conclusion verifiable or falsifiable by experiment. The reason I attach importance to this doctrine of the identity or continuity of transfer of energy is because it greatly simplifies the fundamental mechanical laws, and emphasizes without risk of vagueness the denial of action at a distance.

If action at a distance (no matter how minute) can ever occur, then indeed the continuous transfer of energy breaks down. But observe that there is no necessity for the transfer to occur at a finite velocity in order to avoid action at a distance, *i.e.* action without a medium. By the thrust of an incompressible pole, energy is transferred from butt to tip, just as really as if the compressed and recoiling layers could be demonstrated and its velocity measured. So likewise the pull of gravitation may be (and *pro tem.* I believe is) transmitted by an incompressible (or nearly incompressible) ether, so that the force is felt instantaneously (or nearly instantaneously) at all distances where matter exists; but that by no means militates against a genuine act of transfer. The conservation of matter makes experiments on gravitation difficult; if we could suddenly create or destroy a piece of matter there might be some remote chance of determining the rate at which its gravitative influence was felt. Especially if by alternately generating and destroying it we could set up a series of waves of perhaps measurable length.

And although this is as yet impossible, many known facts lead us to conclude that if gravitation has any velocity at all short of infinite, it is at least immensely greater than the speed of light. And seeing that the one phenomenon is concerned with the transverse (electric) elasticity of ether, and the other with its longitudinal elasticity, there is nothing surprising in that.

By all means, however, as Mr. Heaviside urges, let gravitation be included in general etherial equations whenever possible; and it may perhaps be wise to assume some unknown finite rate of propagation and trace its consequences with the object of verifying or disproving them.

So far as I understand, however, this is not unlike what Helmholtz did, by his generalization of Maxwell's electromagnetic theory; with the result that the course of experiment so far has been to justify the simple Maxwellian theory, and to make the longitudinal ether thrust velocity practically infinite.

And now for the second assertion, that whenever energy is transferred from one body to another, it is also transformed, and *vice versâ.* This is to me not an opinion, but a demonstrated theorem (as has been shown in the paper referred to); but it must be understood in what sense I consistently use the word body in this connection. I do not necessarily mean a visible lump of matter. The molecules of a lump are to be regarded as a different "body" to the whole mass; and again, the ether everywhere embathing them is another distinct "body."

But so long as a piece of matter is merely moving through space with all the energy it may happen to contain, I do not consider that a transfer at all. There is a transfer of energy in one sense, viz. that of locomotion, but there is no transfer from one body to another except when work is done at their point of contact, and energy gained by one and lost by the other, being transferred across their common boundary surface. In all such cases of "activity" the energy transferred is necessarily in the first instance transformed; though by means of another transfer it may very speedily be transformed back again; and so speedily sometimes is the re-transformation effected that the intermediate condition has a tendency to get overlooked. In wave-motion a transfer and transformation occurs during every quarter period.

Mr. Heaviside seems to think that the mere convection of energy should be included as one kind of transfer; but surely that is scarcely convenient? So long as energy retains its form and adherence to one body, so long there is no true activity; no work is being done—the energy is simply stored. It may be stored in a bent spring, or in a flying bullet, or in a revolving fly-wheel. It is impossible to have kinetic energy at all without convection, and a distinction must be drawn between the mere existence of energy and the active and useful flux or transfer of the same.

Mr. Heaviside further seems to consider circuital fluxes of energy as strange and useless phenomena. But I see no reason in this at all. The circulation of matter—for instance in the inner circle of the Metropolitan railway—is, I suppose, considered useful. The circulation of commodities is the essence of commerce. So does the circulation of energy constitute the activity of the material universe. It is the act of transfer that is beneficial (or the reverse); what becomes of a conservative quantity is a minor matter. It must go somewhere, and may very well, after a series of transfers, ultimately return to its starting point. [Parenthetically I should like to preach here against what I hold to be the pernicious doctrine of (at least amateur) political economists, that because money locally spent is not destroyed, but remains in the community, it does not much matter how much transferring power is permitted or granted to one individual,—as if the money itself were the useful commodity, and not the power of determining its direction of transfer or non-transfer. The control of every transfer should be jealously watched, for that is the greedily-desired power.]

So long as circuital convection of energy goes on *without* transfer—as, for instance, in the rim of a non-working fly-wheel—so long the energy is merely *stored*; but directly a belt is fitted on with different tensions in its two halves, a portion of the energy is tangentially tapped off, and transfer and activity begin. The kinetic energy of the wheel is converted into strain or stress energy of the belt, which then by simple locomotion passes it on to something else. I perceive, however, that there is a slight difficulty about this simple case of locomotive conveyance of stress energy by a really inelastic substance; but only because the details of any infinitely rapid process are difficult to follow. I perceive moreover that in many cases it is not worth while to attend to the alternate compressions and motions which constitute a longitudinal pulse, and that the idea of simple locomotion may be conveniently introduced to cover the case of a stressed body moving; but the convenience is I think only attained by shutting our eyes to the essential processes which in all actual matter must be occurring.

I trust that Mr. Heaviside may find time to notice this letter, and attack anything he disagrees with, in order that the whole matter may become thoroughly clear. OLIVER LODGE.

A Proposed Handbook of the British Marine Fauna.

I AM obliged to Prof. Thompson for his criticism of my scheme, although only one of the points he raises is new to me —as I think it will be to most zoologists—viz. that "there are *no* nematophores on the stem" in *Antennularia*. I thought *A.*

ramosa had nematophores on the stem, *and I think so still.* Some of his other remarks are so very obvious as to have scarcely required mention, at any rate to biological readers; a few, however, are just such debateable points as I was anxious to have opinions upon from as many naturalists as possible, and I am glad to know Prof. Thompson's. I am glad to say a number of biologists have written to me, since the scheme appeared in NATURE, expressing general approval, and criticising various points of detail, and some of them kindly making offers of assistance in special groups—and without that kind of assistance from specialists I need scarcely say it would be impossible to carry out the work satisfactorily. The proposal was first brought before the Biological Society of Liverpool on November 11, and it was only after some weeks of intermittent discussion with some of my friends in that Society (such as Dr. Hanitsch, Mr. Isaac Thompson, and Mr. A. O. Walker) who are specialists in certain groups of marine invertebrata, and after correspondence with Canon Norman and other biologists, that I sent the scheme to NATURE, with the view of getting further opinions. Consequently some of the debateable matters alluded to by Prof. Thompson (limits of British area, introduction of certain non-British forms, specific nomenclature, how to treat records of size and distribution, best terms to use for zones of depth, and, I may add, for relative abundance) have already been considerably discussed. The other points raised by Prof. Thompson in connection with *Antennularia* only require a few words. I said *A. ramosa* was *usually* branched. Prof. Thompson says it "may sometimes" be unbranched. The difference between these statements is slight. As to dimensions, a zoophyte which grows to 12, or occasionally to 24, inches in height, will, of course, be also frequently found of smaller sizes; and it might be the best plan to give the extreme range, say, 1 to 24 inches. What I gave was the fair average size of most of the specimens dredged or seen in collections, which I still consider to be 6 to 9 inches.

The rest of Prof. Thompson's contention is practically that there are great difficulties in the way of drawing up such a book of the known British marine invertebrate animals, and that if it is ever done it will be more or less incomplete, because Canon Norman and others (I hope including both Prof. Thompson and myself) will continue to find new British animals. That is perfectly true—in fact obvious—but the same objection applies more or less to every work on systematic zoology that has ever been published; and I do not consider that because our British Pycnogonids, and some other small groups, are still very imperfectly known, that is any sufficient reason for delaying indefinitely an attempt to deal with the rest of the invertebrata. On the contrary my opinion is rather that an approximation is better than nothing, and that every group, or every family, reduced to "Handbook" form with specific diagnoses and figures must be a distinct gain. I hope Prof. Thompson will not think that I am trying to dispute all his criticisms, or that I am ungrateful for the trouble he has taken. I have no doubt that he could correct me in many details, and give me great assistance in records, &c., of zoophytes, pycnogonids, and other groups, and I hope he will do so. W. A. HERDMAN.

University College, Liverpool, January 20.

PROF. D'ARCY THOMPSON'S letter raises a question which is, I think, well worthy of Prof. Herdman's consideration. That a handbook of our marine fauna is needed cannot for a moment be doubted, and the only matter that calls for discussion is one of scope and method, of ways and means. Prior to the appearance of Prof. Herdman's circular and article I had intended, if possible, to bring this very matter before the British Association at its next meeting, believing that a select Committee of the Association would best be able to further the interests of marine zoology in this respect. But, as the matter now stands, I leave any such action very willingly to Prof. Herdman's initiative.

Put broadly (although I well know that such a work in Prof. Herdman's hands would by no means have the character of a mere compilation), the question at issue is whether the handbook should be mainly a compilation from existing material, or should express the work of various specialists and be based upon a series of special investigations. For myself I agree with Prof. Thompson, and for the same reasons, that the adoption of the latter alternative would be likely to meet our needs most fully and satisfactorily. It would ensure, as far as possible, the equal treatment of the various groups, and would thus give to the book (which is important) a more permanent and authoritative value than could be attained by a book depending upon the personal labours of one zoologist. I feel confident that, should Prof. Herdman admit the force of this consideration and be willing to edit a handbook in which the diagnoses were drawn up for the various groups by specialists or specially-chosen investigators, he would find no difficulty whatever in meeting with willing co-operation.

But I hardly see the point of extending the scope of the work to the extent which Prof. Thompson would seem to desire. We need a handbook for use around the coasts of our own islands. To include the fauna of the whole North Atlantic would needlessly add to the size of the work, delay the time of its appearance, and even in the end be incomplete; while it is doubtful whether the advantages would at all outweigh these defects. W. GARSTANG

Marine Biological Association, Plymouth, January 20.

Fossil Plants as Tests of Climate.

MR. J. STARKIE GARDNER, in his interesting review of Mr. Seward's valuable essay, makes a statement which I fancy may be misinterpreted at page 268 of NATURE, where he speaks of the fragmentary character of the Arctic tertiary plants, and the inexperience of the collectors. He doubtless is referring to the remains of certain supposed "palms and cycads in the Greenland Eocene," but those who have not followed this branch of Arctic research would hardly gather from the review that Prof. Heer has determined a magnificent flora of more than 350 species from these northern tertiaries, and that he at once pointed out the absence of tropical and subtropical forms, and the fact that large leaves are not only perfectly preserved up to their edges, but that upright trees associated with their fruits and seeds prove them to have grown on the spot. "Thus of *Sequoia Langsdorffi*," he writes, "we see not only the twigs covered with leaves, but also cones and seeds, and even a male catkin."[1]

In April 1875 I endeavoured to give an abstract of all that was then known of Arctic geology, in a series of articles that appeared in your columns (NATURE, vol. xi. pp. 447, 467, 492, and 508), and added some general conclusions of my own, which are further accentuated in the joint communications of Colonel Feilden and myself to the Geological Society in 1878, and in the "Geology Appendix" to Sir George Nares' "Voyage to the Polar Sea," in which expedition Colonel Feilden played a most valuable part. I have ever since carefully followed the progress of Arctic research, and am now of opinion that looking to the identity of a large number of species (often extending to the varieties of the same) occurring in the Silurian, Carboniferous, Lias, Oolite, Cretaceous, and Tertiary strata of the Arctic regions, with those occurring in similar strata in Europe and other parts of the world, they point to a common temperature over these areas and probably over the whole world, from Silurian to early Cretaceous times, and that this was the case does not appear to me to be affected by the question as to whether or not these deposits were homotaxeous.

In late Cretaceous times commenced *horizontal* variation of cold, or what we now term "climate," though previously *vertical* variation had evidently been present, for the later investigations of Messrs. Blanford appear to place beyond doubt the existence of glaciers in geological times, as was suggested in 1855 by my lamented chief, Sir Andrew Ramsay; but I equally fail to see that the slightest evidence has been anywhere adduced to support the theory of "recurrence of ice-ages," originated by my talented colleague the late Dr. Croll, and now supported with a "modification" by Sir Robert Ball.

The facts, whether we look to the history of plant life, or animal life, or the character of the rocks themselves, appear to me to be all the other way, as they disclose nothing resembling the refrigeration that, gradually increasing in the Tertiary epoch, culminated in the Glacial episode, which choked up the North and Irish Seas with an ice-sheet since man has been an occupant of our islands. CHAS. E. DE RANCE.

H.M. Geological Survey, Alderley Edge, Manchester.

Racial Dwarfs in the Pyrenees.

IN consequence of evidence that I had obtained as to the existence of a dwarf race in Spain, I wrote to Mr. McPherson,

[1] "On the Miocene Flora of North Greenland," by Prof. Oswald Heer. Translated by R. H. Scott, F.R.S., Brit. Assoc., 1867, pp. 53.

our Consul at Barcelona, and enclose his reply. There have long been rumours of survivals of a dwarf or a prehistoric race existing in parts of Spain, but careful inquiries at Madrid failed to supply any definite information on the subject. Last summer on reading over an old number of *Kosmos* (Paris, 1887), I found a brief paragraph referring to a pigmy race having been found in the province of Gerona, Spain, who had slightly Mongolian eyes, yellow, broad, square faces, height from 1 m. 10 to 1 m. 15, and red hair.

An Austrian gentleman recently told me he had seen, in the market-place at Salamanca, some very under-sized peasants, with broad faces and mahogany-coloured woolly hair.

You will see that these accounts all agree substantially, and that these dwarfs and those of Africa are precisely similar.

I have got a deal of information from an old Spanish woman who belongs to a half-breed nano family, and who says that there are in such families frequently nanos (or "enanos") who have red tufts of wool, and are as small as ordinary small boys. But these tufts of wool are peculiarly characteristic of dwarf races nearly everywhere.

I shall write more fully as to my inquiries among half-breed nanos; but they are of very secondary interest now that we can find pure racial nanos within easy reach.

It is most fortunate that they live in the Valley of Ribas and the Col de Tosas, within a little more than a half-day's journey from Toulouse. Some health-seekers or tourists in the South of France may perhaps feel inclined to pay a visit to these little people.

Should the suggestion be acted on, and prove satisfactory, a line to myself on the subject, addressed to 28, Pall Mall, would be highly valued. R. G. HALIBURTON.

Tangier, January 9.

[COPY.]

"*British Consulate, Barcelona, December* 10, 1892.

"DEAR SIR,—Since I received your letter of November 18 and its enclosures I have endeavoured to ascertain what truth there is in the statement that pigmies, or 'enanos' (not 'nanos') exist in the Valley of Ribas. From conversations I had with various individuals who have visited that district it appears certain that a race of men, of about from one metre to one metre and twenty centimetres high, of a darkish complexion (copper-coloured), dark hair and woolly, and flat, broad nose, live in that district, particularly in the 'Collado de Tosas.' They are active, and are generally employed as shepherds. It is also asserted that they are not very intelligent, and that they appear to understand and to make themselves understood with difficulty. It would be an easy journey to go to that place from this town. I had no little difficulty in finding out that such a race lived in that place, for many of the persons with whom I have spoken on the subject were evidently confused and confused me, as besides these, evidently racial pigmies, there are in that neighbourhood many 'cretins,' which were at times described to me as if these were the 'enanos' I spoke about. I am now certain that there are cretins and pigmies in the Valley of Ribas. It is stated that the 'enanos' are rapidly disappearing, and that latterly many have died of smallpox. The men you speak of, who were seen at Salamanca, are, I should say, natives of the Batuecas, or rather of Los Hurdes. These men were discovered in the sixteenth century, and they were then and are even now, in an almost absolute state of savagery." [The remainder as to this race is omitted, as it does not appear that they are nanos.—R. G. H.]

"Yours very truly,
(Signed) "WM. MCPHERSON.

"R. G. Haliburton, Esq."

British Earthworms.

I WRITE to suggest—in connection with the recent letters in NATURE upon this subject—that some one give a thoroughly trustworthy list of British earthworms, with the memoirs in which the species were originally described, and the chief characteristics of each. Dr. Benham would be doing very useful and acceptable work if he were to accomplish this. From what I understand everybody has been making mistakes, and the whole matter is in the utmost confusion. It is very necessary that such a classification should exist, if only for the benefit of those who are working on the earthworm more from a comparative anatomist's than from a specialist's point of view.

FRANK J. COLE.

Zoological Department, Edinburgh, January 12.

DANTE'S "QUÆSTIO DE AQUA ET TERRA."

"Quæstio Aurea ac perutilis edita per *Dantem Alagherium*, poetam florentinum clarissimum, de natura duorum elementorum Aquæ et Terræ disserentem."

"Lo, the past is hurled
In twain: up thrust, out staggering on the world,
Subsiding into shape, a darkness rears
Its outline, kindles at the core, appears
Verona."—R. BROWNING, "Sordello," Book i.

"TO all and each who shall see this document, *Dante Alighieri* of Florence, the least amongst true philosophers, wishes health in Him who is the Beginning of truth and the Light.

"Be it known unto ye all that whilst I was at Mantua there arose a certain question, the which after having been many times dilated upon rather for vain show than for Truth's sake, still remained undecided. Wherefore I, since from boyhood I have been nurtured continually in love of Truth, could not bear to leave the question undiscussed; but I thought fit to show the truth concerning it and to dissolve the arguments adduced to the contrary, both for love of Truth and hatred of Falsehood. And lest the malice of many who are wont to fabricate envious lies against the absent should behind my back alter what was well said, I have moreover thought fit to leave written down on paper what I proved, and to set forth the form of the whole disputation."

These are the words with which Dante commences this "golden and most useful" inquiry concerning the nature of the two elements, earth and water. The treatise is little known in comparison with the other writings of the poet;[1] but although rejected by Ugo Foscolo and others as "impostura indegna d'esame," its genuineness and importance are now almost universally admitted; and without yielding unreservedly to the enthusiastic opinion of an Italian geologist (Stoppani) that there are more truths relating to cosmology to be found prognosticated, affirmed, and even demonstrated in these few pages of the supreme poet than in all the writings of the middle ages taken together, we may nevertheless acknowledge it to be a work of the greatest interest and importance, and by no means unworthy of the singer of the "Divina Commedia."

It seems to be the last work of the poet's life, written at that period which he himself describes in his sonnet to Giovanni Quirino:—

"Lo Re, che merta i suoi servi a ristoro
Con abbondanza, e vince ogni misura,
Mi fa lasciare la fiera rancura,
E drizzar gli occhi al sommo consistoro
E qui pensando al glorïoso coro
De' cittadin della cittade pura,
Laudando il Creatore, io creatura
Di più laudarlo sempre m'innamoro."
—Sonetto xliv. ed. Fraticelli.[2]

Dante was at this time the guest of Guido Novello di Polenta at Ravenna. About the commencement of the

[1] It is, I believe, the only one of Dante's writings that has not yet been translated into English.

[2] "The King by whose rich grace His servants be
With plenty beyond measure set to dwell,
Ordains that I my bitter wrath dispel
And lift mine eyes to the great consistory;
Till, noting how in glorious quires agree
The citizens of that fair citadel,
To the Creator I, His creature, swell
Their song, and all their love possesses me."
—Rossetti's translation in "Dante and his Circle."

year 1320, he seems to have gone for some unknown reason to Mantua, and there to have entered upon this discussion, which he then completed at Verona. The disputation took place at this latter city on January 20, 1320, as Dante himself tells us, in the church of St. Helena (where in recent years the metropolitan chapter have put up a monument in commemoration of the event). All the clergy of Verona were present, except some few who, in the words of Rossetti—

> " Grudged ghostly greeting to the man
> By whom, though not of ghostly guild,
> With Heaven and Hell men's hearts were fill'd."
> —" Dante at Verona."

From a passage which occurs in the course of the treatise, one might almost think that ladies also were present, but let not the reader therefore conclude that the assemblage which listened to Dante's eloquence in that little Veronese temple resembled so many modern philanthropical and other associations in being chiefly composed of ladies and clergymen, for doubtless Can Grande della Scala himself was present to do honour to his former guest, and his poetic fame, which we know to have already spread far and wide, would certainly have brought together as many as the church could hold.

The question to be solved is whether, on any place on the earth's surface, *water* is higher than the *earth*. This question, Dante tells us, was generally answered in the affirmative, and he gives us the five chief reasonings adduced in support of it, of which perhaps the most striking is this one :—

" If the earth were not lower than the water, the earth would be entirely without waters, at least in the uncovered part, and so there would be no fountains, nor rivers, nor lakes. So water must be higher than the earth. For water naturally flows downwards, and the sea is the source of all waters, and if the sea were not higher than the earth, the water would not flow to the earth, since in every natural motion the source of the water must be higher."

Another is this :—" Water seems chiefly to follow the motion of the moon, as is evident in the flow and ebb of the sea, and therefore since the moon's orbit is eccentric, it seems reasonable that water in its sphere should be eccentric too ; and another argument shows that this cannot be unless it be also higher than the earth."

Such be their arguments, but sense and reason alike are against them, and Dante proceeds to explain how he will treat the question. First, he will prove that it is impossible that water in any part of its circumference be higher than this emergent or uncovered earth on which we dwell. Secondly, he will prove that this emergent earth is everywhere higher than the surface of the sea. Thirdly, he will urge arguments against his own demonstrations, and then demolish these objections. Fourthly, the final and efficient cause of the elevation and emergence of the earth will be shown. Fifthly, he will demolish the five chief arguments of the other side which he has already stated.

1. It is impossible that water in any part of its circumference be higher than the earth.

There are only two ways whereby water can thus be higher than the earth : either the water must be *eccentric*, or, if it be *concentric* with the earth, it must be *gibbous* in some part. By water being *eccentric*, Dante means the centre of its natural sphere to be out of and different from the centre of the earth ; by being *gibbous*, Dante means some part of its sphere to be raised up so as to form a protuberance or hump, just as he considers the earth on which we live to be a protuberance or gibbosity of the spherical surface of the earth.

He now shows by means of diagrams that neither of these things are possible, but first makes these two statements—(1) Water naturally flows downwards ; (2) Water is by nature a labile body and has not a boundary of its own, but takes the boundary of the thing in which it is contained.[1]

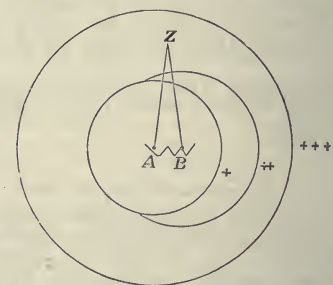
We may compare with this a modern definition of a fluid :—

" A perfect fluid is a body whose form can be changed to any extent, provided its volume remain constant, by the application of a stress, however small, if we allow it sufficient time."—Garnett, " Treatise on Heat."

In the first place, *water cannot be eccentric.*

For if it were so, then three impossibilities would follow —(1) Water would naturally flow both upwards and downwards ; (2) water would not be moved downwards by the same line as the earth ; (3) an equivocation would arise in speaking of the *gravity* of water and of earth ; all which things are seen to be not only false but impossible.

The demonstration *ab absurdo* follows thus :—Let the heavens be the circumference on which are placed three crosses ; water the circumference on which are two ; earth the circumference on which is one cross.



Let the centre of heaven and earth be at point A, the centre of water at point B. Thus A, being the centre of the universe, is the lowest spot of all, and everything which has in the world a position alien from A must be higher. Now if there be any water at A and the way be open to it, it will naturally flow to its own centre, B, since it is the property of every heavy body to move to the centre of its own sphere. But the motion from A to B is a motion upwards ; therefore water will flow *upwards*, which is impossible.

Again, let there be at Z a lump of earth and some water, and let there be nothing to hinder. Then, since it is the property of every heavy body to move to the centre of its own sphere or circumference, the *earth* will move in a straight line to A, and the *water* in a straight line to B, and this, from the figure, must needs be along different lines. This, says Dante, is not only impossible, but would make Aristotle laugh if he were to hear it.

The third impossibility follows thus :—*Gravity* and *levity* are " passions " of simple bodies which are moved with linear motion, and *light* bodies tend upwards and *heavy* tend downwards, by " heavy " and " light " being meant that which has the power of being moved. If now water moved to B and earth to A, since these are simple bodies and heavy, they will be moved down to different centres. If this were so, the word *gravity* would have an *absolute* signification with respect to earth and *relative* with respect to water. This is what the argument amounts to, and so there would be an equivocation of meaning in the word " gravity."

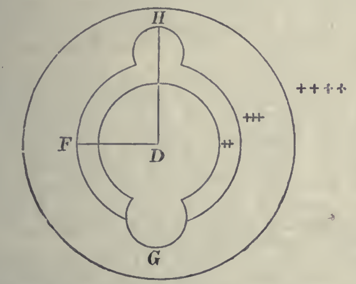
Therefore, *ab absurdo*, water in its natural circumference is not eccentric or out of the centre common to the circumference of the earth.

In the second place, *water cannot be gibbous.*

[1] " Aqua est labile corpus naturaliter, et non terminabile termino proprio." —§ xi.

Let the heavens be where are four crosses, the water where three, the earth where there are two.

Let D be the centre of *earth* and concentric *water* and *heaven*. Water cannot be concentric with the earth unless the earth be in some part "gibbous" above the central circumference. Let the protuberance of the earth be at G, and at some part of the circumference of water let there be a protuberance of water at H. Then let a line be drawn from D to H and another from D to F; it is manifest



that D H is longer than D F, and therefore the summit of one is higher than the summit of the other. Since both touch at their summit the surface of the water without passing beyond, it is clear that the water of the protuberance will be higher, with regard to the surface where F is. Since, therefore, there is no obstacle, the water of the protuberance will flow down until it become level at D with the central or regular circumference. And thus it will be impossible for a protuberance of water to last or even to exist.—Q.E.D.

Dante now brings forward a subsidiary argument to show that probably water has no protuberance out of the regular circumference. The protuberance of the earth is sufficient to prove and explain everything, and "Quod potest fieri per unum, melius est fieri per unum quam per plura." So there is no protuberance on the surface of the water, because God and Nature always do what is best and do not work in vain.

Since water cannot be eccentric, as was shown by the first figure, nor concentric with a protuberance, as was shown by the second figure, it is necessary that water be concentric and coequal, *i.e.* equally distant in every part of its circumference from the centre of the world.

Thus it has been proved impossible for water in any part of its circumference to be higher than the surface of the earth; and so the first point is completed.

We now pass on to the second.

2. This emergent earth is everywhere higher than the surface of the sea. This is shown in this way:—

All the shores of the ocean, as well as of the Mediterranean seas, rise above the surface of the sea which bounds them, as is clear to the eye. Therefore all the shores are further from the centre of the world, since the centre of the world is also the centre of the sea and the shoreward surfaces are parts of the whole surface of the sea; and since everything that is more remote from the centre of the world is also more high, it follows that the shores everywhere rise above the surface of the sea. And if the shores are higher than the sea, much more must be the other regions of the earth, since the shores are the lower parts of the earth, as we see by the rivers flowing down to them.

3. In accordance with the order of the question as at first stated by Dante, he now brings forward various arguments which seem to contradict his demonstrations, and these arguments he then proceeds to demolish. They need not detain us here. In the course of the operation there occurs a most interesting distinction between *homogeneous* and *simple* bodies, in which I seem to see a distinct foreshadowing of our modern view of the chemical elements in contradistinction to the ordinary four or five elements of Aristotle and his followers. "Corpora enim homogenea et simplicia sunt; *homogenea ut aurum depuratum;* et corpora simplicia, ut ignis et terra." § xviii.

But perhaps it might not be out of place to quote here the following passage from G. H. Lewes's "Aristotle":—"One of the great difficulties in interpreting ancient opinions is to guard against the tendency of reading our fulness of knowledge into their vague expressions. We often find in ancient works the precious metal we have ourselves brought with us; as the alchemist often unconsciously put into his crucible the gold, which he afterwards discovered there with surprised delight."—G. H. Lewes, "Aristotle," x. § 170.

He thus sets forth the *final* cause of the elevation or emergence of the earth: There must needs be a part in the universe where all *miscibilia*—to wit, elements—can come together; this cannot be unless the earth be in some part emergent. Thus, although earth, according to its own nature, tends always downwards, it has in it another nature by which it obeys the intention of Universal Nature, and allows itself to be here and there raised up, in order that mixture of the elements may be possible, and thence all things that are subject to generation and corruption may be formed.

He further shows that the emergent earth on which we dwell has the form of a semilune, by arguments which he graciously tells us that even ladies can follow—"Manifestum esse potest etiam mulieribus."

4. What now is the *efficient* cause of the elevation or emergence of the earth above the surface of the water?

Dante first shows that neither the *earth* itself, nor *water*, nor *air*, nor *fire* can be the efficient cause. Therefore it must be referred to the *heavens*. But there are many heavens, and to which are we to refer it? Dante shows that it cannot be referred to the *moon*, nor to the heavens of any of the planets (Mercury, Venus, the Sun, Mars, Jupiter, Saturn), nor yet to the Crystalline Heaven or *Primum Mobile*, the 9th sphere. Now, since the only mobile bodies which remain are the Heaven of the Stars, *Cœlum Stellatum*, or 8th circle, we must refer the cause of the elevation of the earth of our hemisphere to that. This Heaven of the Stars has at once unity in substance and multiplicity in its virtues or influences, as the poet himself sings:—

"Il ciel, cui tanti lumi fanno bello,
Dalla mente profonda che lui volve
Prende l'image, e fassene suggello.
E come l'alma dentro a vostra polve,
Per differenti membra, e conformate
A diverse potenzie, si risolve;
Così l'intelligenzia sua bontate
Multiplicata per le stelle spiega,
Girando se sovra sua unitate."
—"Paradiso," ii. 130 138.[1]

Dante further refers the elevation of our earth to that region of the Cœlum Stellatum which roofs over this uncovered earth; that is, that this elevating virtue or influence is in those stars which are in the region of the heaven, which is bounded by the equator and the circle which the pole of the zodiac describes around the pole of the world; "whether it elevate by way of attraction as

[1] "The heaven, which lights so manifold make fair,
From the Intelligence profound, which turns it,
The image takes, and makes of it a seal.
And even as the soul within your dust
Through members different and accommodated
To faculties diverse expands itself,
So likewise this Intelligence diffuses
Its virtue *multiplied* among the stars,
Itself revolving on its *unity*."
"Paradiso," ii. 130–138, Longfellow's trans.

the magnet draws the iron, or by way of impulsion, generating impelling vapours, as in certain mountains." A truly scientific and most suggestive remark!

We may compare the last clause with those well-known lines of the "Inferno," in which is described how the earth, and likewise the mountain of Purgatory were formed when Lucifer fell from Heaven:—

"Da questa parte cadde giù dal cielo;
E la terra, che pria di qua si sporse,
Per paura di lui fe del mar velo,
E venne all'emisperio nostro: e forse
Per fuggir lui, lasciò qui il luogo voto
Quella ch'appar di qua, e su ricorse."
—"Inferno," xxxiv. 121-126.[1]

But now it may be asked, Since that region of the heaven moveth circlewise, why did not this elevation happen circlewise? Because, Dante answers, the matter was not sufficient for so great an elevation. Then why was the elevation of the earth produced in our hemisphere rather than in the other? To this, says Dante, we must answer as Aristotle does (in "De Cœlo," book ii.) in answer to the question why the heavens move from east to west and not contrariwise, that such questions proceed either from much folly or from much presumption, because they are above our intellect. God made all things for the best, and when He said, "Congregentur aquæ in locum unum et appareat arida," then were the heavens virtuated to act and the earth potentiated to be passive.

"Let therefore men cease," cries Dante, "yea, cease from inquiring into those things which are above their intellect, and let them strive to the utmost of their power to raise themselves to things immortal and divine, and so leave those things which exceed their understanding. Let them listen to Job:—'Numquid vestigia Dei comprehendes, et omnipotentem usque ad perfectionem reperies.'—(Job xi. 7.) Let them hearken to the words of the Psalmist: 'Mirabilis facta est scientia tua; et me confortatus est, et non potero ad eam.'—(Ps. cxxxviii.) Let them hear Isaiah speaking in the person of God to man: 'Quam distant cœli a terra, tantum distant viæ meæ a viis vestris.'—(Is. lv. 9.) Let them hear the voice of the Apostle to the Romans: 'O altitudo divitiarum scientiæ et sapientiæ Dei! quam incomprehensibilia judicia ejus, et investigabiles viae ejus!'—(Rom. xi. 33.) Lastly, let them hearken to the very voice of the Creator, saying: 'Quo Ego vado, vos non potestis venire.'—(S. John vii. 34). And let these things suffice for the inquiry of the truth before us."

We may most fittingly compare this Dantesque passage with the close of Galileo Galilei's famous "Dialogo intorno ai due massimi sistemi del mondo, tolemaico e copernicano," which I here venture to translate:—

"*Simplicio.* If either of you were asked, If God in His infinite power and wisdom could confer upon the element of water the reciprocal movement which we perceive in it, in another way than by the moving of the vessel containing it, I know that you would answer, that He could have done so in many ways, even unimaginable by our intellect; whence I immediately conclude that, this being so, it would be excessive daring for any one to wish to limit and restrict the Divine power and wisdom to a particular phantasy of his own.

"*Salviati.* An admirable and truly angelical doctrine, to which very conformably answers that other divine doctrine, which, whilst it allows us to dispute about the constitution of the world, adds (perhaps in order that the exercise of human minds be not suppressed nor grow lazy) that we are not to find out the work of His hands. Let therefore the exercise permitted and ordained to us by God make us recognize and so much the more wonder at His greatness, as we find ourselves the less competent to penetrate into the profound abysses of His infinite wisdom.

"*Sagredo.* And this will serve for the last conclusion of our four days' argument."—Galileo Galilei, "Dialogo dei Massimi Sistemi, Giornata quarta."

Dante now briefly deals with the five arguments which he mentioned at the beginning of his treatise as the most important against his theory. These being made short work of, he concludes:—

"This philosophical question was determined by me, Dante Alighieri, the least of philosophers, beneath the sway of that invincible lord, Messer Cane Grande della Scala, for the holy Roman empire, in the illustrious city of Verona, in the church of S. Helena, and in the presence of all the Veronese clergy, save some few who, aflame with too much charity, do not admit the postulates of others, and through virtue of humility poor of the Holy Spirit, shun being present at their discourses, lest they may seem to approve their excellence.

"Now this was done in the year from the Nativity of our Lord Jesus Christ, 1320, on Sunday, which the Saviour injoined on us to venerate for His glorious Nativity and His wondrous Resurrection. The which day was the 7th from the ides of January and the 13th before the calends of February" (*i.e.* January 20).

I have dealt merely with the chief parts of this Dantesque dissertation. According to Signor A. Stoppani ("La questione dell' Acqua e della Terra di Dante Alighieri," in "opp. Lat. di Dante," ed. Giuliani, vol. ii.) there are nine truths relating to cosmology, presaged, affirmed, and in part demonstrated. These nine he makes out thus:—

(1) The moon the principal cause of tides.
(2) Equality of the sea's level.
(3) Centripetal force.
(4) Sphericity of the earth.
(5) Dry land simply protuberance of the earth's surface.
(6) Northern grouping together of the continents.
(7) Universal attraction.
(8) Elasticity of vapours a motive power.
(9) Heaving up of the continents.

Let me now add a tenth: A vague foreshadowing of our modern idea of chemical elements as distinct from those of Aristotle, or at least of homogeneous chemical bodies; "Corpora enim homogenea et simplicia sunt; homogenea, ut aurum depuratum; et corpora simplicia, ut ignis et terra."

EDMUND G. GARDNER.

Caius College, Cambridge.

[1] "Upon this side he fell down out of heaven;
And all the land, that whilom here emerged,
For fear of him made of the sea a veil,
And came to our hemisphere; and peradventure
To flee from him, what on this side appears
Left the place vacant here, and back recoiled."
—"Inferno," xxxiv. 121-126, Longfellow's trans.

MOROCCO.[1]

MOROCCO has a paradoxical place in the history of exploration; although the only part of Africa fully in sight from the shores of Europe, and dotted with one or two half European coast towns, its interior is more firmly closed to the traveller, sportsman, and missionary than the dense forests of the Congo, or even the shores of Lake Chad. The difficulties in the way are not physical, nor are they wholly political. They arise mainly from the deeply-rooted antagonism in race and creed between the inhabitants of Morocco and all Christendom —this quaint and semi-fossil phrase is still here a necessary and sufficient term. At this moment public atten-

[1] "Bibliography of the Barbary States." Part IV. A Bibliography of Morocco from the earliest times to the end of 1891. By Lieut.-Col. Sir R. Lambert Playfair and Dr. Robert Brown.

tion is turned somewhat intently on the political conditions of the Oriental despotism which has so anomalously maintained itself to the west of our prime meridian. Hence the politician has a temporary interest in what would otherwise have appealed mainly to the geographer and man of science, the publication by the Royal Geographical] Society of a "Supplementary Paper," the "Bibliography of Morocco." This is a work of splendid thoroughness, almost, if not quite, exhaustive in its list of 2243 titles, and made convenient for reference by two copious indexes of subjects and authors. But it is much more than a catalogue. Comments, judiciously brief, but in some cases of exceptional interest extending to a couple of pages, give information as to little-known authors, or record some striking circumstance in or concerning the books referred to. There is a specially-compiled map, and an introduction which is really an essay on the growth of knowledge regarding Morocco in European countries. With regard to the map, it is explained that only the coast-line has been surveyed. As to the interior :—

"The best mapped districts are laid down solely from running *reconnaisances* or sketch-maps. Positions fixed by astronomical observations are few. Many wide areas have never been visited by any Europeans, and most of the Atlas is at this hour as little known as it was in the days of Leo Africanus. There are cities within a few hours' ride of Tangier, which no person capable of giving a correct account of his observations has visited; and there are others not much farther away, to attempt to enter which—Zarhoun, for example—would, were the intruder detected, be certain death. There is scarcely a river laid down with even approximate accuracy, and, not to enumerate more distant provinces, the entire Riff country, that bold *massif* which is familiar to the thousands who every year sail up and down the Mediterranean, is less explored than many regions in the centre of the continent."

The present population of Morocco is a puzzle almost as difficult, although on a smaller scale, as that of China. The authors of the Bibliography give 4,000,000 as an estimate, but the guesses of various authorities vary between $1\frac{1}{2}$ and 15 millions. The roads shown on the map are mere mule and camel tracks made by the feet of the pack-animals, unaided by any engineer. Ferries are rare, and, of course, bridges are unknown in the interior. The distribution of towns and villages is often at variance with the rules holding for civilised countries. The villages are built out of the way of the main tracks, because people never travel in Morocco for the good of the inhabitants, and it is safer to live off the path of the tax-collector and the Government official, who demands free food and quarters. The great number of place-names on the map of so thinly-peopled a country is due to the fact that the tombs of saints are such important landmarks that they must be indicated, even if only a few persons live beside them. "All the places beginning widh 'Sidi' (Lord, master) are either actually tombs or the tomb has formed, as in so many of our cathedral cities, the nucleus of the town or village." "Sok," another affix of frequent occurrence, means market-place, and many of the established sites for periodical fairs are uninhabited between the gatherings of people from far and near. Many of the place-names on the coast exist in two forms at least—the native word and its Portuguese or Spanish translation; Casablanca and Dar-el-beida (both meaning White house) for example. We regret that the authors did not see their way to lay down precise rules for the spelling of Moorish place-names, either by giving a standard transliteration of the Arabic, or a uniform phonetic system. Indeed, even in the introduction a few anomalous spellings are found, *e.g.* *Zarhoun* and *Zerhun*, *Moulai* and *Mowlai*.

The physical geography of Morocco appears to be changing, and the natural conditions of the country are less favourable for agriculture than they were a few centuries ago. The forests have been destroyed with such recklessness that the soil has been dried up and swept away in many places; there is evidence that the rainfall has diminished, lakes have dried, and rivers formerly navigable have become silted up, or alternate as dry tracts of stone and raging torrents.

In one respect alone—the enthusiastic Moslemism of its people—does Morocco show no sign of degeneration. Although the Moors can no longer seize and hold the Christian slaves, whose stories bulk so largely in the bibliography, their hatred and contempt towards "unbelievers" is in no sense abated. Into such a land no Europeans could penetrate far, except in the past as slaves, or now as official messengers of European Powers under special protection, jealously watched and prevented from studying places or people. The last serious attempt at scientific exploration—that of Mr. Joseph Thomson—was again and again almost stopped by the fanatical Kaids, and only his remarkable persistence and daring stratagems carried him as far as he reached. Such stratagems would hardly serve again, and for the present the exploration of the Atlas Mountains, with their half-guessed topography, imperfectly-known flora, and unsurveyed mineral wealth is at an end. The futility of disguise as an aid to exploration is fully proved in the records before us, where the ghastly fate of many who tried to pass as Moslems, and the unsatisfactory results obtained by others who escaped alive, are briefly told.

It seems to us that an attempt might well be made to open communications with fanatical Mohammedan countries either by explorers or diplomatic agents of the same faith, and there must be many amongst the educated Mohammedans of India who are well suited for such work. The religious beliefs of a people with whom belief and conduct are so closely related, must be taken into account in dealing with them, just as much as the physical features of a country. And as Arctic sailors have been proved to be the natural explorers in the Antarctic seas, Swiss mountaineers the safest pioneers on New Zealand glaciers, and Canadian boatmen the most expert in shooting the Nile cataracts, so Mohammedan envoys might be expected to make the most favourable impression on the people of Morocco or of the Mohammedan Sudan.

Sir Lambert Playfair and Dr. Brown deserve the heartiest thanks for completing their Bibliography of the Barbary States in such an admirable way, and we do not doubt that the work will be very widely consulted in the immediate future.

THE RATE OF EXPLOSION IN GASES.

THE following is an abstract of the Bakerian Lecture on "The Rate of Explosion in Gases," delivered before the Royal Society by Prof. Harold B. Dixon, on January 19 :—

1. Berthelot's measurements of the rates of explosion of a number of gaseous mixtures have been confirmed. The rate of the explosion wave for each mixture is constant. It is independent of the diameter of the tube above a certain limit.

2. The rate is not absolutely independent of the initial temperature and pressure of the gases. With rise of temperature the rate falls; with rise of pressure the rate increases; but above a certain *crucial pressure* variations in pressure appear to have no effect.

3. In the explosion of carbonic oxide and oxygen in a long tube, the presence of steam has a marked effect on the rate. From measurements of the rate of explosion with different quantities of steam, the conclusion is drawn that at the high temperature of the explosion wave, as

well as in ordinary combustion, the oxidation of the carbonic oxide is effected by the interaction of the steam.

4. Inert gases are found to retard the explosion wave according to their volume and density. Within wide limits an excess of one of the combustible gases has the same retarding effect as an inert gas (of the same volume and density), which can take no part in the reaction.

5. Measurements of the rate of explosion can be employed for determining the course of some chemical changes.

In the explosion of a volatile carbon compound with oxygen, the gaseous carbon appears to burn first to carbonic oxide, and afterwards, if oxygen is present in excess, the carbonic oxide first formed burns to carbonic acid.

6. The theory proposed by Berthelot—that in the explosion wave the flame travels at the mean velocity of the products of combustion—although in agreement with the rates observed in a certain number of cases, does not account for the velocities found in other gaseous mixtures.

7. It seems probable that in the explosion wave—

(1) The gases are heated at *constant volume*, and not at *constant pressure*;

(2) Each layer of gas is raised in temperature *before* being burnt;

(3) The wave is propagated not only by the movements of the burnt molecules, but also by those of the heated but yet unburnt molecules;

(4) When the permanent volume of the gases is changed in the chemical reaction, an alteration of temperature is thereby caused which affects the velocity of the wave.

8. In a gas, of the mean density and temperature calculated on these assumptions, a sound wave would travel at a velocity which nearly agrees with the observed rate of explosion in those cases where the products of combustion are perfect gases.

9. With mixtures in which steam is formed, the rate of explosion falls below the calculated rate of the sound wave. But when such mixtures are largely diluted with an inert gas, the calculated and found velocities coincide. It seems reasonable to suppose that at the higher temperatures the lowering of the rate of explosion is brought about by the dissociation of the steam, or by an increase in its specific heat, or by both these causes.

10. The propagation of the explosion wave in gases must be accompanied by a very high pressure lasting for a very short time. The experiments of MM. Mallard and Le Chatelier, as well as the author's, show the presence of these fugitive pressures. It is possible that data for calculating the pressures produced may be derived from a knowledge of the densities of the unburnt gases and of their rates of explosion.

NOTES.

The forty-sixth annual general meeting of the Institution of Mechanical Engineers will be held on Thursday evening and Friday evening, February 2 and 3, at 25, Great George Street, Westminster. The chair will be taken by the president, Dr. William Anderson, F.R.S., at half-past seven on each evening. The annual report of the council will be presented to the meeting on Thursday, and the annual election of the president, vice-presidents, and members of council, and the ordinary election of new members will take place on the same evening. The following papers will be read and discussed, as far as time permits:—Description of the Experimental Apparatus and Shaping Machine for Ship Models at the Admiralty Experiment Works, Haslar, by Mr. R. Edmund Froude, of Haslar (Thursday); description of the Pumping Engines and Water-Softening Machinery at the Southampton Water Works, by Mr. William Matthews, Waterworks Engineer (Friday).

Prof. Cayley, we are glad to learn, is now convalescent.

We greatly regret to have to announce the death of Mr. H. F. Blanford, F.R.S. He died on Monday at the age of fifty-eight.

Prof. Michael Foster, Sec.R.S., has been appointed Rede Lecturer at Cambridge for the present term. His Rede lecture will be delivered early in June.

The Bill for the introduction of a standard time (mean solar time of the fifteenth meridian) was read a second time in the German Imperial Parliament on Monday. The measure was accepted without much discussion.

An excellent report on technical education in London has been submitted to the London County Council by a special committee appointed to investigate the subject. The report was prepared by Mr. Llewellyn Smith, the committee's secretary, and displays a thorough grasp of the essential conditions of the problem. It is proposed that a Technical Instruction Board shall be appointed, and that it shall consist of some members of the Council, and of representatives of the School Board, the City and Guilds of London Institute, the City Parochial Charities, the Head Masters' Association, the National Union of Elementary Teachers, and the London Trades Council. The committee think that one-third of the amount derived from the beer and spirits duties should be handed over to this body for the provision of adequate technical instruction in all parts of London.

The French Minister of the Interior has established at Marseilles, in connection with the university, an institute for botanical and geological research, and a museum. The director is Prof. Heckel, who, as well as a curator and a librarian, gives his services gratuitously.

In the year 1793 was published Christian Konrad Sprengel's "Das entdeckte Geheimniss der Natur, im Bau und in der Befruchtung der Blumen," the work which first directed the attention of naturalists to the contrivances which, in many flowers, render self-pollination difficult, and promote the visits of insects to assist cross-pollination. The copper-plate illustrations of this work still maintain their character as among the best that have been published in this branch of science. Sprengel was in many respects a forerunner of Darwin, and centenaries have been celebrated on slighter grounds than the publication of this work.

The chief characteristics of the weather during the past week have been its general mildness and dampness; the day temperatures have at times exceeded 50° in most parts of the kingdom, but at night slight frosts occurred towards the end of last week in Scotland and the south-eastern parts of England. The distribution of pressure has been complex, a series of depressions have passed over the coast of Norway from the westward, while an anticyclone lay over the south-western parts of our islands, the reading of the barometer in the south-west being about an inch higher than in the north of Scotland. The passage of the low-pressure systems in the north was accompanied by strong north-westerly winds and gales in Scotland, with hail or sleet in many places. Owing to the disappearance of the anticyclone from the continent, north-westerly winds became prevalent over western Europe, and a rapid rise of temperature occurred there, amounting to 30° in Germany between the 20th and 21st instant. During the last few days fresh depressions have approached our north-western coasts, with increasing winds from the south-west, and

a continuance of mild, unsettled weather appeared probable. The *Weekly Weather Report* shows that for the week ending the 21st instant there was a large deficiency of rainfall in the west of Scotland, south-west of England, and south of Ireland. The percentage of possible duration of sunshine ranged from 28 in the south-west of England to 7 in the south of England and to 3 in the north of Scotland.

THE *Repertorium für Meteorologie*, vol. xv. recently issued by the Imperial Academy of Sciences of St. Petersburg, contains a discussion by P.A. Müller, of the Ekaterinburg Observatory, at the foot of the Ural Mountains, in the Government of Perm, on the question of the evaporation from a snow surface. Several writers, among whom are Drs. Brückner and Woeikof, differ in opinion as to whether the evaporation from a snow surface exceeds the condensation of the aqueous vapour of the air immediately above it. The method generally adopted for the decision of the question is to find whether the temperature of the snow surface is above or below the dew-point of the surrounding air; in one case there would be evaporation, and in the other condensation. The paper occupies forty-seven small folio pages, and the observations were made hourly from December 21, 1890, to February 28, 1891. The result of the investigation shows that according to the temperatures of the dew-point and of the surface of the snow, the evaporation of the snow greatly exceeds the condensation of the aqueous vapour, for the condensation occurred at only 27 per cent. while the evaporation occurred at 73 per cent. of the hourly observations.

PROF. FLINDERS PETRIE, to whose introductory lecture at University College, Gower Street, we referred last week, delivered on Saturday the first of his regular course of lectures on the Edwards Foundation. He said the Egypt of the early monuments was a mere strip of a few miles wide of green, amid boundless deserts, and beneath a sky of the greatest brilliancy; a land of extreme contrasts of light and shadow, of life and death. These conditions were reflected in the art. On the one hand was the most massive and overwhelming construction, and, on the other, the most delicate and detailed reliefs. On the one hand, the most sublime and stolid statuary; on the other, the course and accidents of daily life freely treated. On the one hand, masses of smooth buildings that far outdo the native hills on which they stand, gaunt and bare, and, on the other, the vivid and rich colouring in the interiors. In consequence of the climate also Egypt is a land of great simplicity of life, and simplicity is especially the characteristic of the oldest Egyptian buildings. Speaking of the early Egyptian statues, Prof. Petrie said that the race represented by them appears as "one of the noblest that ever existed."

AT Leeds, on Monday, Lord Playfair presided at a public dinner, held in support of the Yorkshire College. In proposing the principal toast—"The Yorkshire College"—he spoke of the efforts made half a century ago to secure for science the place which rightly belongs to it in the educational system. He was glad, he said, that these efforts had met with a temporary resistance, because if the Universities had at once yielded there would have been no colleges now in our great provincial towns. The colleges, he thought, were adapting themselves rapidly and well, upon the whole, to the genius of their several localities. Of the Yorkshire College he said that she had fitted herself for the liberal culture and life-work of a great industrial centre. "No doubt her technical courses are peculiar. Actual laboratories for spinning, for dyeing, for tanning, for engineering, are novel adjuncts to a college. What does it mean? That you are trying to strengthen and embellish industrial pursuits, as the Universities acted upon the professions when they were obliged to include them. Surely a great town like Leeds is right when it imbues its producers with intellectual knowledge, as well as with technical expertness. Such men in future carve out industrial professions for themselves, and illumine them by appropriate culture."

THE interesting address lately delivered by Sir Henry Roscoe on the occasion of the prize distribution at the Birmingham Municipal Technical School has now been issued separately. He describes the report of the first year's work as "more than encouraging." Speaking of the building which is to be erected for technical training at Birmingham, he says:—"You in Birmingham have, in my judgment, taken the right course. You are not going to squander your money by using it for a thousand different purposes. You are, I hope, going to do a good thing, and a big thing, in building and equipping a really great institution, worthy of your city and of your well-earned renown as being foremost amongst our towns in educational matters. You will have a place of higher technical instruction to which all the Midlands will look up. It will be the gathering ground for all the youthful talent of the busy millions of the district. It will be here that the future Faradays, and Priestleys, and Watts will get that sound though elementary scientific training which will enable them to pursue that training to its highest point at the Mason College here, or in other colleges elsewhere, which may in the end make both them and their country great."

THE new technical schools connected with University College, Nottingham, which were formally opened the other day, promise to be of immense service, not only to Nottingham itself, but to the wide district of which it is the educational centre. A remarkably clear description of the buildings, with plans, is given in a pamphlet prepared for the ceremonial opening. The pamphlet also includes an interesting summary of the facts relating to the history of the Nottingham College and its technical department.

MR. C. F. JURITZ, Senior Analyst in the Department of Lands, Mines, and Agriculture, Cape Colony, announces in the *Agricultural Journal*, issued by the Department, that a comprehensive series of investigations with reference to the chemical composition of the various soils of the colony is about to be undertaken. The samples of soil are to be collected by one of the officers of the analytical branch of the Department. In the first instance the southern part of the Malmesbury district will be visited, and soils will be taken from several localities representative (*a*) of primary and (*b*) of alluvial soils belonging to the Malmesbury beds of clay slate. Mr. Juritz proposes next to collect soils from the more northerly portion of the same district, in the vicinity of Hopefield, for instance, after which the Caledon district will be taken in hand. These analyses when completed will afford, he points out, an insight into the general composition of the clay slate soils, lying around the south-western coast of the Colony between Donkin's and Mossel Bays. The Government of Cape Colony look upon the proposals that have been made as "a move in the right direction," and have promised their warmest support.

MR. KEDARNATH BASU, describing in *Science* some relics of primitive fashions in India, says he does not see the same profusion as he saw ten or twelve years ago, of tattoo-marks and red-ochre or red oxide of lead (*sindur*) over the forehead and crown among the women of Bengal. The rapid progress of female education and the consequent refinement in æsthetic taste are, he says, the causes of the decline of this rude and savage adornment. The people of Behar, the North-western provinces, and other districts, however, still cling to these remnants of savagery. The up-country women, besides tatooing their bodies and painting the head with red paint, bore the lower lobes of their ears,

and insert big and heavy wooden cylindrical plugs, which almost sever the lobes from the ears. The plugs are sometimes as big as two inches in length with a diameter of an inch and a half, and as much as two ounces in weight. These heavy plugs pull down the lobes of the ears as far as the shoulders, and give the wearers a hideous look.

Mr. F. J. Bliss contributes to the new "Quarterly Statement" of the Palestine Exploration Fund a most interesting report on the excavations at Tell-el-Hesy during the spring season of 1892. Speaking of the now famous tablet discovered in the course of these excavations, he says:—"On Monday, May 14, ten days before we closed the work, I was in my tent at noon with Ibrahim Effendi, when my foreman Yusif came in with a small coffee-coloured stone in his hand. It seemed to be curiously notched on both sides and three edges, but was so filled in with earth that it was not till I carefully brushed it clean that the precious cuneiform letters were apparent. Then I thought of a day, more than a year before, when I sat in Petrie's tent at the pyramid of Meydûm, with Prof. Sayce. He told me that I was to find cuneiform tablets in the Tell-el-Hesy, which as yet I had never seen; and gazing across the green valley of the slow, brown Nile, and across the yellow desert beyond, he seemed to pierce to the core, with the eye of faith, the far away Amorite mound. As for me, I saw no tablets, but I seemed to be seeing one who saw them!" Mr. Bliss also notes that the discovery was a triumphant vindication of Mr. Flinders Petrie's chronology—established, not by even a single dated object, but by pottery, mostly plain and unpainted. It is announced in the "Quarterly Statement" that the excavations at Tell-el-Hesy are now being vigorously carried on by Mr. Bliss, who has recovered from his serious illness.

It seems that in Yucatan and Central America, as in Egypt and other countries, ancient monuments are held in small respect by certain classes of travellers. According to Mr. M. H. Saville, assistant in the Peabody Museum, who writes on the subject in *Science*, enormous damage is being done to many of the most interesting antiquities in these regions. The magnificent "House of the Governor" in Uxmal, described as probably the grandest building now standing in Yucatan, is almost covered with names on the front and on the cemented walls inside. These names are painted in black, blue, and red, and among them are the names of men widely known in the scientific world. The "House of the Dwarfs" in the same city has suffered in like manner, and many of the sculptures which have fallen from the buildings in Uxmal have been wilfully broken. In Copan, when the Peabody Museum Honduras Expedition compared the condition of the "Idols" to-day with the photographs taken by Mr. A. P. Maudslay seven years ago, it was found that during that time some of the very finest sculptures had been disfigured by blows from machetes and other instruments. The Stela given as a frontispiece in Stephens' "Incidents of Travel in Central America," vol. i., has been much marred by some one who has broken off several ornaments and a beautiful medallion face from the northern side. One of the faces and several noses have been broken off from the sitting figures on the altar figured by Stephens in the same volume, opposite page 142; and on some of the idols and altars names have been carved. While excavating in one of the chambers of the Main Structure, members of the Expedition uncovered a beautiful hieroglyphic step, but before they had time to secure a photograph of it, some visitor improved the opportunity while no one was about to break off one of the letters. In Quirigua a small statue, discovered by Mr. Maudslay and removed by him to a small house near the rancho of Quirigua, had the head and one of the arms broken from it during the interval between two visits. This statue was of the highest importance, as it very much resembled the celebrated "Chaac-mol" now in the Mexican Museum, but discovered by Le Plongeon at Chichen Itza. Much mischief is also done by natives, who think nothing of tearing down ancient structures in order to provide themselves with building materials. The authorities of the Peabody Museum, to whom the care of the antiquities of Honduras has been granted for a period of ten years, deserve much credit for the efforts they make to cope with the evil. They have caused a wall to be built round the principal remains in Copan, and a keeper has been placed in charge with strict orders to allow nothing to be destroyed or carried away.

What is the true Shamrock? Most Irishmen are probably of opinion that they can answer the question correctly, but unfortunately they do not all give the same reply. Mr. Nathaniel Colgan, who has been investigating the subject, collected thirteen specimens from the following eleven counties—Derry, Antrim, Armagh, Mayo, Clare, Cork, Wexford, Wicklow, Carlow, Queen's County, and Roscommon. Shamrocks were thus secured from northern, southern, eastern, western, and central Ireland, Mr. Colgan's correspondents in the various counties taking pains to have each sample selected by a native of experience who professed to know the genuine plant. All the specimens were planted and carefully labelled with their places of origin, and flowering within some two months later gave the following results: eight of the specimens turned out to be *Trifolium minus* of Smith, and the remaining five *Trifolium repens* of Linnæus. Cork, Derry, Wicklow, Queen's County, Clare, and Wexford declared for *Trifolium minus*; Mayo, Antrim, and Roscommon for *Trifolium repens*; and Armagh and Carlow, each of which had sent two specimens, were divided on the question, one district in each county giving *T. repens*, while the other gave *T. minus*. These results are set forth by Mr. Colgan in an interesting paper in the first volume of the *Irish Naturalist*, to which we referred last week. Elsewhere in the same volume Mr. R. L. Praeger suggests that authentic specimens of shamrock should be obtained from every county in Ireland, and he adds that he has no doubt Mr. F. W. Moore would gladly grow them at Glasnevin Gardens, if Mr. Colgan did not care to nndertake so large an order. Mr. Praeger notes that in his own district, North Down, *Trifolium minus* is always regarded as the true shamrock, but that a luxuriant specimen, or one in flower, is generally discarded as an impostor.

The waters of the Great Salt Lake, Utah, are known to vary in salinity at different times. Dr. Waller, of Columbia College, gives the results of his recent determination of the dissolved salts in the *School of Mines Quarterly*. A comparison of his results with those obtained by Gale, Allen, Bassett, and others, shows a constant change of salinity, and a closer examination reveals a variation from place to place. This is due to local differences in the amount of evaporation, and to the influx of water, fresh or saline, in many cases from subterranean springs which give no indication of their presence. For some of the constituents the water is nearly at saturation point, and differences of temperature are also apt to cause slight differences of composition. The presence of lithium and bromine strengthens Captain Bonneville's conclusions with regard to the basin of the ancient lake called after his name, and now represented by the Great Salt Lake and its lesser neighbours. The benches of sand and gravel seen high up on the flanks of the Wahsatch mountains and the Oquirrh range indicate the eastern and western shores of the old lake, whose waters must have covered an area equal to that of Lake Huron, or ten times that of the Great Salt Lake. Successive lowerings of level finally cut off its outlet to the north, by which it used to flow into the Pacific Ocean.

A BEAUTIFUL optical phenomenon, which has not yet been satisfactorily explained, is described by M. F. Folie in the *Bulletin* of the Belgian Academy. It was observed about a mile from Zermatt on August 13 at 8.30 a.m. "On our right, towards the east, on the steep flanks of the mountains which enclose the valley of the Viège, rose a group of fir trees, the highest of which projected themselves against the azure of the sky, at a height of 500 m. above the road. Whilst I was botanising my son exclaimed: 'Come and look: the firs are as if covered with hoar-frost!' We paid the most scrupulous attention to the phenomenon. To make sure that we were not misled by an illusion we made various observations, both with the naked eye and with an excellent opera-glass." It was observed that not only the distant trees, but those lining the road, glittered in a silvery light, which seemed to belong to the trees themselves, and that the insects and birds playing round the branches were bathed in the same light, forming an aureole round the tops of the trees, somewhat resembling the light effects observed in the Blue Grotto. It is suggested that the light was reflected from the snow. Since it disappeared as soon as the sun rose above the hill, and has never been seen except in the presence of snow, this explanation appears plausible, but it is highly desirable that further and more detailed observations should be made of this *spectacle féerique*.

THE Tasmanian Official Record is henceforth to be issued tri-annually instead of annually, and a handbook has been issued to take its place during the intervening years. This handbook (which is described on the title-page as "for the year 1892") contains a brief epitome of the historical portion of the Official Record, and summarises in a convenient form the more important statistical information contained in the detailed tables of the last volume of the general statistics of the colony.

MESSRS. ASHER AND CO. will publish shortly an English translation of the "Recollections of the Life of the late Werner von Siemens," the well-known electrician, and brother of Sir William Siemens. Two editions of the German original, published in December last, were issued in the course of a few weeks.

THE course of four winter lectures in connection with the London Geological Field Class will this year be delivered by Prof. H. G. Seeley, F.R.S., on Tuesday evenings, at the Memorial Hall, Farringdon Street, the subject being "The Fossil Reptiles of the Thames Basin." All particulars may be had of the Hon. Sec. Mr. J. H. Hodd, 30 and 31, Hatton Garden, E.C.

THE bacterial purification which takes place in a river during its flow has been recently attributed in part to the process of sedimentation which the micro-organisms in the water undergo, but it would seem that yet another factor must be taken into account. Buchner, in some investigations which he has recently published ("Ueber den Einfluss des Lichtes auf Bakterien," *Centralblatt für Bakteriologie*, vol. 11, 1892, also vol. 12, p. 217) shows that this diminution of the numbers present may be also assisted by the deleterious action which light exercises upon certain micro-organisms. A systematic series of experiments was made by introducing typhoid bacilli, *B. coli communis*, *B. pyocyaneus*, Koch's cholera spirilla, also various putrefactive bacteria, into vessels containing sterilized and non-sterilized ordinary drinking water. As a control, in each experiment one vessel thus infected was exposed to light, whilst a second was kept under precisely similar conditions, with the exception of its being covered up with black paper, by means of which every particle of light was excluded. The uniform result obtained in all these experiments was that light exercised a most powerful bactericidal action upon the bacteria in the water under observation. For example, in one water in which at the commencement of the experiment 100,000 germs of *B. coli communis* were present in a c.c., after one hour's exposure to direct sunlight *none* were discoverable, whilst in the darkened control flask during the same period a slight increase in the numbers present had taken place. Even the addition of culture fluid to the flasks exposed to sunlight could not impair in the least the bactericidal properties of the sun's rays. In the flasks exposed to diffused daylight the action was less violent but still a marked diminution was observed. In his later experiments Buchner has employed agar-agar, mixing a large quantity of particular organisms, pathogenic and others, with this material in shallow covered dishes and then exposing them to the action of light and noting its effect upon the development of the colonies. For this purpose strips of black paper cut in any shape (in the particular dish photographed by Buchner letters were used) were attached outside to the bottom of the dish, which was then turned upwards and exposed to direct sunlight for one to one and a half hours and to diffused daylight for five hours. After this the dish was incubated in a dark cupboard. At the end of twenty-four hours the form of the letters fastened to the bottom of the dish was sharply defined, the development of the colonies having *taken place in no part of the dish, except in those portions covered by the black letters.* Some interesting experiments on the same subject have also recently been made by Kotljar (*Centralblatt für Bakteriologie*, December 20, 1892). In the course of these investigations the author found that of the coloured rays of the spectrum the red favoured the growth of those bacteria experimented with, whilst the violet rays acted prejudicially, although less so than the white rays. The exceedingly interesting observation was made that the violet rays actually favoured the sporulation of the *Bac. pseudo anthracis*.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mr. A. Sandbach; a Triton Cockatoo (*Cacatua triton*) from New Guinea, presented by Mr. Arthur Harter; a Gannet (*Sula bassana*) British, presented by Mr. F. W. Ward; two Tuatera Lizards (*Sphenodon punctatus*) from New Zealand, presented by Mr. W. H. Purvis; two Wanderoo Monkeys (*Macacus silenus*) from the Malabar Coast; a Straw-necked Ibis (*Carphibis spinicollis*) from Australia; four Snow Buntings (*Plectrophanes nivalis*); six Wild Ducks (*Anas boschas*, 3 ♂ 3 ♀) British, purchased; a Meadow Bunting (*Emberiza cia*) European, received in exchange; two Shaw's Gerbilles (*Gerbillus shawi*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET HOLMES.—*Edinburgh Circular*, No. 37, announces that Palisa, telegraphing from Vienna, states that Comet Holmes now resembles an 8 m. star with a nebulous envelope 20″ of arc in diameter.

A further observation made by Prof. Schur in Göttingen on January 19 showed that the nucleus was of the 10th magnitude, and could not be considered at all brighter than that magnitude. For the latter observation the air, as regards clearness, was all that could have been desired.

At South Kensington, on January 18, the comet was observed as a hazy star and estimated to be about the 8th magnitude.

The following ephemeris is that given by Schulhof:—

Date.	R.A. app. h. m. s.	Decl. app. ° ′ ″
Jan. 26 ...	1 35 33·0 ...	+33 42 3
27 ...	36 58·7 ...	42 51
28 ...	38 25·1 ...	43 44
29 ...	39 52·1 ...	44 43
30 ...	41 19·8 ...	45 46
31 ...	42 48·1 ...	46 55
Feb. 1 ...	44 17·0 ...	48 8
2 ...	1 45 46·5 ...	33 49 26

On January 30 the comet will lie very nearly between β Andromedæ and β Trianguli, about one-third of the distance from the latter star.

COMET BROOKS (NOVEMBER 19, 1892).—The following ephemeris of Comet Brooks is due to Ristenpart, and is given in *Astronomische Nachrichten*, No. 3142:—

1893.	R.A. (app.) h. m. s.	Decl. (app.) ° ′	Log r.	Log Δ.	Br.
Jan. 26	23 35 8	+40 34·3	0·0921	0·0471	2·94
27	38 53	39 34·1			
28	42 22	38 36·8	0·0950	0·0688	2·62
29	45 37	37 42·2			
30	48 40	36 50·2	0·0981	0·0898	2·35
31	51 32	36 0·5			
Feb. 1	54 14	35 13·1	0·1015	0·1101	2·11
2	23 56 48	34 27·7			

This comet, which will be found to be in the constellation of Andromeda, will lie about 3½° to the south of *i* Andromedæ on January 27.

PHOTOGRAPHIC ABSORPTION OF OUR ATMOSPHERE.—The question of the degree with which our atmosphere absorbs photographic rays has become very important owing to the adoption of photography, so that any work enlightening us on this subject is anxiously listened to. Prof. Schaeberle, who has been making investigations in this direction, has just completed a memoir which is being published by the University of California, but in the meanwhile he has issued a table setting forth simply the final results. The absorption in the following table is expressed in photographic magnitudes, and must be added to the unknown atmospheric absorption at the zenith.

Z. D. °	Phot. Absorp.	Z. D. °	Phot. Absorp.
5	0·00	50	0·44
10	0·01	55	0·56
15	0·04	60	0·71
20	0·07	65	0·89
25	0·11	70	1·12
30	0·16	75	1·45
35	0·21	80	1·94
40	0·28	85	2·68
45	0·35	90	5·00

HARVARD COLLEGE OBSERVATORY.—The forty-seventh annual report of this Observatory, by Prof. Pickering, opens with a reference to the death of Mr. George B. Clark, to whose "genius for mechanical devices, indomitable perseverance, and devotion to the interests of the observatory, we are indebted for the success of many of our most useful instruments." Of the most important matters mentioned in the report are the permanent establishment of an observing station in South America, where the unsteadiness of the air is for the most part eliminated, the construction of a suitable building for the housing of photographs and the approaching completion of the Bruce photographic telescope. The work done with the various instruments during this period has been considerable. With regard to the Draper telescope, as many as 2777 photographs have been taken, while those taken with the Bache instrument number nearly 2000. The Boyden department, which is situated at Arequipa, in Peru, has been making great progress, the results of which have been frequently inserted in *Astronomy and Astrophysics*. The eight surfaces of the objective of the Bruce telescope have, as Prof. Pickering informs us, been ground and polished, and the results up to the present, according to tests made on a star, are very satisfactory. This instrument, when finished, is destined for the Arequipa station.

SOLAR OBSERVATIONS AT ROME.—Prof. Tacchini has issued the results of the observations made with regard to the distribution in latitude of the solar phenomena at the Royal Observatory during the third semester in 1892. From the tabulated statement which he gives the following facts may be gathered.

With regard to the eruptions, these phenomena seem to be quite local to the equatorial regions, the relative frequency being 0·667 and 0·333 for the north and south latitudes respectively. The spots, faculæ, and eruptions have their maxima nearly at the same distance from the equator both north and south, the zones being (± 20°, ± 30°), but the maxima for the prominences extend further north, about latitudes 60° north and south. Prof. Tacchini remarks that in the equatorial zone (+20°–20°), where the maxima of faculæ, spots, and eruptions are observed, a feeble relative frequency in the prominences is noted, which shows us that we must consider a large number of prominences as the result of conditions "bien différentes par rapport à celles qui déterminent la production des taches dans la photosphère," whilst the prominences are formed simply in the solar atmosphere. As a case in point, he mentions an observation made on August 1 of last year, of a cloud which, starting at a distance of 264″, rose to 364″ without any corresponding alteration at the surface.

THE TOTAL SOLAR ECLIPSE, APRIL 15–16, 1893.—Writing to M. Flammarion about the scientific expedition sent by the Brazilian Government to study the region of the central plateau and to select a site for the proposed new capital, Dr. Cruls, the Director of the Observatory at Rio de Janeiro, adds the following note:—"About the total eclipse of April 16. Will France send any one to observe it? I beg you to make known through the *Review* (*L'Astronomie*) that the Brazilian Government is willing to send a warship to Ceara, on which foreign astronomers who wished to observe the phenomenon could find a passage."

GEOGRAPHICAL NOTES.

A CHANGE has been made in the arrangements for the expedition to Lake Rudolf referred to on p. 235, vol. xlvii. The expedition is to travel by the Tana river instead of the Juba, although its ultimate destination is the same, and Lieutenant Villiers, instead of accompanying it, has joined Sir Gerald Portal's mission to Uganda.

MR. H. J. MACKINDER, M.A., Reader in Geography at Oxford, delivered the first of a course of ten educational lectures, under the auspices of the Royal Geographical Society, on the relation of geography to history, on the 20th inst. The attendance was largely composed of teachers and University Extension students, to whom special terms were offered. The lecturer treated of "the Theatre of History," tracing the development of accurate geographical knowledge from the earliest times in a series of brilliant generalisations. He dwelt upon the contrast between the knowledge of early Greek geographers regarding the true shape of the earth, and their habitual representation of the regions known to them in a circular form. In the middle ages, amongst the half-learned, the map of the known world was elevated to the highest place, the figure of the globe was forgotten, and the doctrine of a flat earth gained currency. At the geographical *renaissance* the map was adapted once more to the sphere, and the discoveries of Columbus and his contemporaries resulted directly.

THE suggestion of Mr. Joseph Thomson to bestow the name of Livingstonia (vol. xlvii. p. 160) on the British sphere of influence north of the Zambesi, in spite of its singular propriety, has, we fear, failed to convince the authorities in charge of the region, who, it appears, have decided to adopt the cumbrous and scarcely accurate title of British Central Africa.

M. MIZON's second expedition to Adamawa has been stopped on the Benué by the breakdown of his steamers, and the sudden falling of the water, he being left without means of progress about two-thirds of the way between Lukoja and Yola.

THE French flag has been formally hoisted on the little islands of St. Paul and New Amsterdam in the South Indian Ocean, midway between the Cape of Good Hope and Australia. St. Paul is an interesting instance of a volcanic island, the extinct crater of which forms a wide sheltered harbour communicating with the sea by means of a single narrow channel. It was one of the French stations for observing the transit of Venus in 1874. French fishermen from Reunion had practically taken possession of the islands in the early part of the century, but the fishing-grounds have long been abandoned.

MR. B. V. DARBISHIRE, M.A. (Oxon.), has been appointed Cartographer to the Royal Geographical Society. He has had the advantage of preliminary training in Germany, and under the Reader in Geography at Oxford.

THE APPROACHING ECLIPSE OF THE SUN, APRIL 16, 1893.[1]

I HAD the honour, two and a half years ago, of describing to you the total eclipse of the sun of December 22, 1889, which I had been to observe in the Salut Isles, French Guiana. In spite of very unfavourable atmospheric conditions I was then

[1] Address to the Astronomical Society of France, on November 2, 1892, by M. De la Baume Pluvinel, translated by A. Taylor.

able to take some photographs of the phenomena and to measure the actinic intensity of the corona. Two years previously I had been to Russia to observe the eclipse of August 18, 1887, but the bad weather prevented any observations. If these expeditions did not succeed as well as I had hoped, they were at least useful in showing me all the difficulties to be met with in such undertakings, and of convincing me that if one wishes to thoroughly avail one's self of the precious moments during which the eclipse lasts, it is necessary to gain a large experience of these phenomena by omitting no opportunity of observing them, and by making a speciality of these expeditions. Therefore, after the eclipse of 1889 I determined to go to observe the following eclipse, that of the 16th of next April.

This time the phenomenon is visible under particularly favourable conditions. On the African coast to the south of Dakar, where the expedition sent by the Bureau des Longitudes will observe, and where I also propose to instal myself, the duration of totality is four minutes thirteen seconds. Moreover, a very important consideration is that we are certain of fine weather. At a time when expeditions are being organised in every country in view of this astronomical event, I think it will be useful to draw your attention to the chief questions which should be the object of astronomical study during the next eclipse.

You are aware that the passing of the moon before the sun has the inestimable advantage of allowing us to see the circumsolar regions which, under ordinary circumstances, because of their faint light are lost in the general illumination of our atmosphere. The regions thus revealed consist of a layer in immediate contact with the sun, the chromosphere, in which are the rosy flames which form the protuberances; and a more or less extensive luminous aureole, the corona. But since the celebrated eclipse of 1868, which marks an epoch in the history of solar physics, we are able, thanks to the great discovery of Messrs. Janssen and Lockyer, to study the protuberances at any time, and consequently it is only to the corona that the attention of astronomers turns during total eclipses.

An invariable part of the day's programme is the study of the structure of the corona, and the luminous intensity of its various parts. We need to have recourse to photography for trustworthy evidence as to this, for photography alone can give a faithful representation of the phenomena; even the best drawings always leave much to be desired. Indeed, it is impossible in the space of a few minutes to exactly represent a nebulous mass as complicated as the corona, and without any definite outlines. We can judge of the difficulty presented by the drawing of the corona, by remembering that even the most skilful draughtsmen have never yet been able to give us similar drawings of the great Orion nebula, although this may be studied at leisure. The brilliancy of the corona varies in intensity so much from one eclipse to another, that it is difficult to determine beforehand the length of exposure needed with given apparatus to obtain as satisfactory a representation of the phenomenon as possible. Moreover, the different parts of the corona differ in brilliancy, so that when the photographic action is sufficient to give a good image of the middle part, the lower portions which form the interior corona are over-exposed, while the extreme limits of the aureole are not reproduced. To satisfy all the conditions it is necessary to take several photographs with different exposures.

To advantageously discuss the results obtained it is very important that astronomers should place upon each plate a uniform scale to measure the intensity of the photographic action upon it. This intensity is equal to the product of three factors; the effectiveness of the object glass, the length of exposure, and the sensitiveness of the plate. If we indicate the useful diameter of the object glass by a and the focus by f, the effectiveness, defined by the international congress of photography, is $100\frac{a^2}{f^2}$. If we take plates of gelatinobromide of silver of normal sensitiveness as our unit, and let t be the length of exposure in seconds, we have the following formula to express the photographic action:—$100\frac{a^2}{f^2}t$. In working with wet collodion plates it is necessary to multiply this expression by $\frac{1}{30}$, and with plates of dry collodion it must be multiplied by $\frac{1}{300}$. The first photographs of the corona, taken with wet collodion, from 1868 to 1878, were obtained with a photographic action not greater than 2. Later, thanks to rapid plates, much greater action could be obtained. Thus in 1883 a photograph obtained by M. Janssen had received a photographic action equal to 918. On the negative thus obtained, the corona extended to between 30′ and 40′ from the limb of the moon, but on the other hand, details of the parts near the sun were completely wanting.

We might ask whether by still further increasing the photographic action we should also extend the limits of the corona? Certainly not! for if the photographic action is too intense, the faint contrast between the extreme parts of the corona and the more or less illuminated sky is no longer appreciable on the negative. We know, indeed, that if we wish to produce the maximum contrast between two half tones we must only use just enough light for the faintest of the half-tones to give a perceptible image. In America, Mr. Burnham has been engaged in determining the maximum length of exposure necessary to obtain the best representation of the corona, and he has made experiments on this subject by photographing the moon and white clouds on a faintly lighted sky.

In 1889, at the Salut Isles, I used five instruments, giving photographic actions varying from 185 to 13, but, doubtless on account of the peculiarly intense illumination of the atmosphere due to the short duration of totality, and the great abundance of water vapour in the atmosphere, the most satisfactory negative was that corresponding to a photographic action of 30. It is very probable that an equally good result might have been obtained with much less photographic action. Mr. Barnard, to whom we owe the best photographs of the eclipse of January 1, 1889, worked with a photographic action equal to 0·58. This result proves that with the sensitive plates now in use it should be possible to obtain good images of the corona on a large scale by using secondary magnifiers to increase the size of the image given by the object glass. In any case we can employ object glasses of two or three metres focal length, which would give images sufficiently large to show all the details of the corona without having resort to enlargement of the plates. Nevertheless, in spite of the use of a long focus, the instrument must remain luminous enough for the time of exposure to be short. The displacements of the image on the plate, caused by the imperfect adjustment of the equatorial mounting, or by an irregularity in the clockwork movement, or by the movement of the sun in declination are thus rendered inappreciable.

The photographs, when obtained, should be examined from the following different points of view. First of all we wish to find if the corona, which will be observed in the month of April, 1893, at a period of great solar activity, and at an epoch when the south pole of the sun is projected on the visible part of its disc, resembles, as we have every reason to think it does, the corona of 1883, which was studied under the same conditions. A great resemblance between the forms of the corona in 1889 and 1878, at the periods of minimum sun-spots, has already been noted, and if it can be established that the corona, seen under similar conditions, presents the same appearance, it will be proved that the diversity of appearance hitherto noticed depends solely upon the state of agitation of the solar surface, and the position of the observer with respect to the solar equator.

If the corona should present an axis of symmetry it must be ascertained whether the poles of this axis coincide with the poles of the axis of rotation of the sun; or if, as is more usually the case, the poles of the corona are inclined at some degrees from the poles of the sun, thus resembling the position of the magnetic poles of the earth with regard to its geographical poles. If the corona shares in the movement of rotation of the sun, it must be the same with its axis of symmetry, and therefore if we once observe the northern pole of the corona to the east of the northern pole of the sun, we ought to find it after an uneven number of half-revolutions, of the sun to the west of the north pole of the sun. To ascertain if this is so or not, it is of the greatest importance to know exactly the orientation of the images upon the photographic plates. The most exact and simple method to orient the images is to place the photographic apparatus in the position which it occupied at the moment of the phenomena, and, in the night, to photograph the trails which the stars leave in passing across the field of the lens.

If the photographs should show the structure of the corona clearly, we shall be able to study the form of those luminous rays which we notice at the poles of the sun, and of those curvilinear structures which seem to extend from the middle latitudes of the sun. The study of the curvature of these structures will be very useful in verifying the exactness of one of the most favoured theories of the corona, which explains the phenomena

by supposing that matter is thrown out by the sun normally at its surface, and that its projection is turned on one side by the rotation of the sun. Mr. Schaeberle, of the Lick Observatory, has mathematically studied this theory, and on applying it to eclipses already observed, has been able to report that the curvature of the structures has always conformed with the theory.

We must also examine the photographs taken with the longest exposure, to determine whether the dark parts which sometimes separate the luminous structures, and which we can trace to the base of the corona, are entirely destitute of light. The existence of these *rifts*, as the English call them, is difficult to explain, if we suppose that the coronal atmosphere entirely surrounds the sun, for in that case we should always see, projected on the plane perpendicular to the line of sight, the coronal matter all round the sun. According to Prof. Hastings, the presence of these rifts is a confirmation of his theory which ascribes the corona to diffraction, and not to the existence of a material mass.

Is the aspect of the corona quickly modified, or are the changes which we notice from one eclipse to another effected slowly? Hitherto we have never proved the difference between the photographs of the same eclipse taken at several hours' interval, and at stations very distant from each other. The English astronomers thought of testing this question in December, 1889, and the two English expeditions sent, one to the Salut Isles, and the other to the west coast of Africa, were furnished with photographic outfits as identical as possible, in order to obtain, at an interval of two and a half hours, comparable negatives of the corona. Unfortunately the complete failure of the expedition on the African coast did not permit the carrying out of this programme; otherwise it is very probable they would have proved no sensible difference between the negatives at the two stations, for photographs show that the corona of December 22, 1889, was almost identical with that of January 1 of the same year. We may say, then, that during the year 1889, a year of quietude on the solar surface, the appearance of the corona did not appreciably change.

However, the experiment attempted by the English expeditions needs to be repeated; if not to study the internal movements of the corona, to obtain identical photographs at two different angles, which would enable us, with the aid of the stereoscope, to judge of the *relief* of the corona.

Photographs of a total eclipse will not only inform us as to the structure of the corona, but will permit us to measure its actinic brightness. We can estimate the relative intensity of different parts of the corona by superposing several photographs, made on the same scale, but obtained with very different photographic actions. The outlines of each image would give lines of equal actinic intensity of the corona. The absolute intensity may be measured by comparing the opacity of the image on the plate with the opacities produced on the same plate from a source of standard light. For this purpose the plates destined for photography are previously exposed on their borders to a standard light for varying periods of time. When these plates are developed, a scale of tones which allows a comparison of opacities is obtained at the same time as the image of the phenomena.

The spectroscopic examination of the corona confronts us with still more complex and more interesting problems. When we keep the slit of the spectroscope on the crescent of the sun, which narrows more and more in proportion as the moon advances, the spectrum darkens and the dark lines become less and less apparent; then all at once the field of sight is covered with an infinite number of bright lines, which seem to be substituted for each dark line of the Fraunhofer spectrum. This phenomenon only lasts two or three seconds. Such is the remarkable observation made by Prof. Young in 1870. In the preceding year he had tried to prove this transformation of dark into bright lines, but failed because he had arranged the slit of his spectroscope as a radius to the sun, which gave the bright lines too little length to be perceptible. With a tangential slit, however, the lines were long enough to be easily recognised.

Prof. Young's observations revealed to us the existence round the sun of a layer of incandescent vapours, of relatively low temperature, which, conformably to Kirchoff's theory, produce by their absorbing power reversal of the lines of the solar spectrum. It is very probable that the vapours to which the reversal is due are not all situated in the atmosphere which Prof. Young has revealed to us, and which has a thickness of only 1000 kilometres. If it were so, absorption must be infinitely more intense at the edge of the sun than it is at the centre. Nevertheless, the borders of the sun show no trace of this abnormal absorption. The observations of M. Janssen in 1867 showed this, and it is also proved by photographs of the spectrum of the sun which I took at the annular eclipse of 1890 at Canœ in the island of Crete.

It is probable that the reversal of lines is produced in a series of layers whose total thickness is great enough to make the difference of absorption between the centre and limb of the sun inappreciable. According to Prof. Lockyer the sun should be surrounded by concentric layers of vapours arranged in order of density, which, according to his own expression, envelope the sun like "the leaves of an onion." Prof. Young's layer of vapours would comprehend only some of these layers. This hypothesis seems confirmed by the observation made by M. Trépied in 1882: although he saw "a veritable rain of bright lines in the spectrum," he proved that the coincidence of the bright and dark lines was not complete.

Prof. Lockyer's theory involves also, as another consequence, the unequal length and width of these bright lines; indeed, the layer nearest to the sun should give short lines corresponding to the thickness of this layer, and as the temperature here must be very high the lines should be rather wide. The following layer being seen by projection, and having a thickness equal to the two layers, should give lines twice as long; moreover, this second layer being cooler than the preceding the lines should be narrower. The same reasoning applies to the succeeding layers, so that we ought to find, soon after the beginning of the total eclipse, short and wide lines, then long and narrow ones. The observations of 1882 confirmed these predictions, and English astronomers wished to repeat the experiment in 1886. Unfortunately the observations of Father Perry and Mr. Turner were made under conditions too unfavourable for us to draw any certain conclusion from them. To fully elucidate the question it is necessary to obtain instantaneous photographs of these bright lines. The experiment was indeed attempted by English observers in 1883, but they seem to have obtained no result. Prof. Lockyer proposes during the approaching eclipse to photograph these lines as well as the bright lines of the corona. He intends to use not only an analytic spectroscope, but a prismatic object glass. This apparatus will give the monochromatic images of the corona, that is to say, the kind of rings corresponding to each elementary radiation emitted by the coronal light.

When we turn the spectroscope towards the corona itself we observe a continuous spectrum, crossed by a bright green line which does not belong to any known element. This line, near the line E, corresponds to the division 1474 of Kirchoff's scale, and was at first believed to coincide exactly with a line of iron; but in 1876 Prof. Young was able to separate the line 1474 with powerful dispersion, and proved that one of its two components belongs to iron while the other belongs to the coronal matter. This line 1474 has been shown in every total eclipse, but its intensity has been very variable and seems always to have followed the fluctuations of solar activity. Thus in 1878, a period of maximum spots, the green line was so faintly visible that it escaped all observers except two. On the other hand, in 1882, when the solar activity was almost at its maximum, the green line was visible to within 40′ from the limb. However, we must remember that these estimations made by different observers, observing with very dissimilar instruments, are scarcely comparable, and trustworthy evidence can only be obtained from photographs of the spectrum of the corona. The new plates sensitive to the green will no doubt allow the line 1474 to be photographed in the approaching eclipse.

It would be interesting to know whether the intensity of the green line varies with the brilliancy of the different parts of the corona, whether it is completely wanting in the rifts, whether it extends further than the visible corona, whether it has the same width in its whole extent, &c. These observations can only be made by associating with the spectroscope a telescope serving as a finder, in which cross wires have been arranged to indicate at each moment towards what part of the corona the slit is directed. The spectrum is observed with one eye while with the other the corona is examined. This is the arrangement which M. Janssen has always adopted in his spectrum observations of the corona.

If the terrestrial atmosphere is loaded with water vapour, we must expect a general diffusion of the coronal light, and this is

doubtless the reason that on some occasions, as in 1870, the green line is seen beyond the corona—even upon the lunar disc.

Prof. Hastings, in 1883, examined simultaneously with a special arrangement the spectra of east and west portions of the corona, and proved, conformably to the theory that he propounds, that the green line varied in length during the duration of the eclipse, and that it always extended furthest on the most illuminated side of the edge of the moon. Mr. Keeler repeated the experiment in 1889, and also noted that the length of the green line depends upon the position of the sun with respect to the moon. The question would be worth studying further.

The green line is not the only bright line in the spectrum of the corona, the hydrogen lines have also been discovered in it, but these never extend further than about 10′ from the sun's limb. Other bright lines in the red and in the violet were observed by M. Tacchini and by Thallon in 1882. It was in 1882 also that Prof. Schuster obtained the first photograph of the coronal spectrum upon which some thirty bright lines may be counted.

In addition to the incandescent solid or liquid matter producing the spectrum of the corona, and the incandescent gases, which give rise to bright lines, there must also be in the circumsolar regions matter reflecting the light of the photosphere, as our own atmosphere does. This is proved by the polarisation of the light of the corona, and by the presence in its spectrum of the dark lines of the Fraunhofer spectrum. We owe the discovery of these dark lines to M. Janssen. In 1871 he observed only the lines D and *b*, but, since, in 1883, he has recognised some hundred dark lines, thus showing that the complete Fraunhofer spectrum is found in the coronal spectrum. These dark lines are necessarily very faint, for they are drowned in the continuous spectrum. As a rule the line D is most conspicuous, although, according to Prof. Hastings, if a faint solar spectrum is projected on to the continuous spectrum of a gas flame, it is not the line D, but rather the group *b*, which is by far the most apparent. Prof. Hastings concludes from this experiment that the continuous spectrum of the corona is richer in green than in orange radiation, since it causes the group *b* to disappear before the line D.

In conclusion I must quote a remarkable observation made by Prof. Tacchini in 1883, which, should it be confirmed, would suggest a very fascinating theory of the corona. Upon examining the spectrum of one of the sheaves (panaches) of the corona with a considerable dispersion and a wide slit, Prof. Tacchini thought he recognised two or three bright bands characteristic of the hydrocarbons, which are always present in the spectra of comets. Father Perry in 1886 proposed to verify the observation of Tacchini, but unfortunately could not re-observe the bands in question. Certainly he used a spectroscope with slightly illuminated cross wires, and when the period of great solar activity had already passed. It would be well in future eclipses to devote some seconds to the search for these bands, for, if the presence of carbon were recognised in the coronal atmosphere, it would be a new proof of the analogy which exists between the corona and cometary masses. Like comets the corona seems formed of matter subject to a repulsive force on the part of the sun, indeed it is probable that solar gravity does not act upon the corona, for unless this were so, the lower parts, having to support the weight of the upper, would be much more dense than the latter. It would thus result that the lines of the coronal spectrum, the line 1474 for instance, would be wider at their bases than at their upper extremities; but nothing of the kind has hitherto been observed. Moreover, so that the corona may be visible at 30′ or 40′ from the sun, the coronal matter must necessarily not be too rare in these extreme regions; but even in ascribing an extremely low density to this, we should find upon allowing for solar gravity that the pressure near the sun would have a considerable value, although it is proved that the pressure at the base of the corona does not exceed some millimetres of mercury.

It is also sought to prove the slight density of the middle corona by the fact that it has never offered any resistance to comets, which, on several occasions, have passed through it; but as comets themselves experience no appreciable resistance when they encounter a body it is impossible to tell whether the absence of resistance is due to the comets or to the corona.

The repulsive force which expels the coronal matter from the sun would act in the same manner as electrical force; indeed Prof. Bigelow has noticed that the arrangement of plumes and sheaves round the solar disc, and the ircurvilinear forms exactly recall the lines of force of an electric field. Let us complete the parallel between comets and the corona by noting that the tails of comets sometimes assume the curvilinear form found in the sheaves of the corona. The dark parts which divide the tails of comets have also their analogues in the rifts of the corona. To push the comparison still further, it would be very interesting to be able to prove that the corona, like cometary masses, is transparent, and that bright stars can be seen through it. Unfortunately it will be impossible to attempt this experiment at the time of the next eclipse.

An exact photometric study of the solar surface would perhaps detect the transparency of the corona, indeed if we suppose that the corona presents a certain opacity the parts of the photosphere on which the large sheaves are projected must be less luminous than the parts covered by the polar rays.

If the corona is not subject to solar gravity it is scarcely probable that it shares the movement of rotation of the sun; however, it would be useful to try in the coming eclipse to study the question by the spectroscopic method, as M. Trouvelot wished to do in 1883. It would be desirable to conduct all spectroscopic observations of the corona by means of photography. The instruments which must be used for this purpose should be very luminous (*i.e.* give bright images), for there is little light available, and the exposures are necessarily short. In studying the effectiveness of a spectroscope in the case of an object presenting a large apparent diameter, like the corona, it is seen that the intensity of the spectrum depends entirely upon the width of the slit, and the effectiveness of the object glass which forms the image of the spectrum. As to the collimator and the condenser their dimensions are of no importance, provided that the collimator can well receive all the light of the condenser. As the object glass which forms the image of the spectrum must have an image long enough to give sufficient length to the spectrum, one is led, in order to obtain great effectiveness, to give this object glass a large aperture, and consequently to use a prism of large size.

The visibility of the bright lines depending not only on their brightness, but also on their width, a wide slit must be employed to obtain a good image of these lines; on the other hand, a narrow slit will give a spectrum of great purity, and will show the dark lines. The employment of two different spectroscopes is then plainly indicated.

It remains for us to speak of the photometric measuring of the corona by optical photometers. Bunsen's photometer has already been used for this purpose, but I think that we must henceforth turn to photography to obtain exact results. The question should not be neglected, for it is certain that the brilliancy of the corona varies considerably from one eclipse to another. Thus Prof. Lockyer estimates that in 1878, at a period of quiescence on the surface of the sun, the corona was ten times less brilliant that in 1871.

Let us end by pointing to the polariscope observations which hitherto have been far from giving concordant results as to the proportion of polarised light in the various parts of the corona. Here also there are new inquiries to be made.

Such, gentlemen, are the different problems suggested by the study of the solar corona. We will hope that the next eclipse will largely contribute to their solution.

MEMORIAL OF SIR RICHARD OWEN.

A MEETING was held at the rooms of the Royal Society, on Saturday, to make preparations for the provision of a suitable memorial of the late Sir Richard Owen. The Prince of Wales took the chair, and was supported by the Duke of Teck, the President, the Treasurer, and the Secretary of the Royal Society, Lord Kelvin, Sir John Evans, and Professor Michael Foster; the President of the British Association, Sir A. Geikie; the President of the Royal College of Physicians, Sir A. Clark; the President of the Royal College of Surgeons, Mr. T. Bryant; the President of the Royal Academy, Sir F. Leighton; the Bishop of Rochester, the Dean of Westminster, Lord Playfair, Prof. Huxley, Sir H. Roscoe, M.P., Sir F. Abel, Sir F. Bramwell, Sir G. Stokes, Sir H. Acland, Sir Joseph Lister, Mr. Ericsen, Dr. Priestley, Dr. Günther, Dr. H. Woodward, Dr. Maunde Thompson, Sir W. H. Flower, Sir Erasmus Ommanney, Sir James Paget, Sir Henry Thompson, Sir Spencer Wells, Sir Edwin Saunders, Sir John Fowler,

Dr. E. A. Bond, Dr. P. L. Sclater, Mr. Carruthers, and Mr. W. P. Sladen. There were also present, among others, Sir G. M. Humphry, Mr. Holman Hunt, Mr. Ernest Hart, Dr. Michael (President of the Royal Microscopical Society), Prof. R. Meldola, Mr. O. Salvin, and Prof. T. Wiltshire.

The Prince of Wales, in opening the proceedings, said,—I have the great privilege conferred upon me of being asked to take the chair to-day, upon this very special occasion. We are assembled together for the purpose of paying a mark and tribute of respect and appreciation to the memory of a great man of science who has lately passed away from us. The name of Sir Richard Owen must always go down to posterity as that of a great man—one who was eminent in the sciences of anatomy, zoology, and palæontology. Perhaps I may be allowed to say a word of my own personal knowledge of him. It is now thirty-five years since I had the advantage of knowing him. When I lived as a boy at the White Lodge, Richmond Park, now occupied by my illustrious relative on my right (the Duke of Teck), I had opportunities of visiting him and knowing him. His geniality and his charm of manner to all those who knew him have, I am sure, left a deep and lasting impression. Whether he was explaining to you the mysteries of some old fossil bone that had been given him, or whether he was telling one of his vivid ghost stories, one felt that one was under the charm of his presence. His method of teaching, as you all know, was earnest and clear in every respect; and it even derived a measure of force from a certain hesitation in his manner. His great repute was gained as a zoologist, and in the study, not only of living animals, but of those long extinct, and following the same large range of work as Cuvier, to whom, in the history of science, he may be regarded as a successor. One of the great works and interests of his life was the formation of the Natural History Museum, which is now safely established in South Kensington under the able guidance of our friend Sir William Flower. It may be within your recollection what great difficulties Sir Richard Owen encountered when he was first appointed Superintendent of the Department of Natural History at the British Museum in 1856. He himself saw in getting that appointment that it was quite impossible that these large collections could be adequately seen unless they were removed to some other sphere. In 1862 a Bill was brought in by Mr. Gladstone, who took the greatest interest in the matter, while it was vigorously opposed, strange to say, by no less great a man than Mr. Disraeli. The Bill was lost, though it was eventually, ten years later, carried, and now we have that fine building that we all know and deeply appreciate. I may also mention that he took the greatest interest with regard to the colonies, and in trying to obtain from them specimens that would be worthily represented in the Natural History Museum. In sanitary matters also he was not behindhand, as was shown by his long intimacy with that distinguished man, Sir Edwin Chadwick. There are several resolutions to be proposed, and you will hear far better and more eloquent remarks from the distinguished gentlemen who will move and second them. That is the reason why on this occasion I shall not trouble you with more remarks. Allow me only to repeat the assurance of the deep interest I take in this movement for a suitable memorial to the memory of this great man, and how deeply I appreciate having been asked to take the chair on this interesting and important occasion.

Lord Kelvin moved:—"That it is desirable that the eminent services of the late Sir Richard Owen in the advancement of the knowledge of the sciences of anatomy, zoology, and palæontology should be commemorated by some suitable memorial." He said that, if there was no other reason but the part that Sir R. Owen took in the establishment of the Natural History Museum, and the success that ultimately attended his efforts, he deserved the gratitude of the nation. There was scarcely any branch of the whole of natural history that he had not touched and enriched with the results of his investigations. Three hundred and sixty papers, every one of them valuable, were to be found under his name in the Royal Society catalogue of scientific papers. From these contributions, however, he came back to the Natural History Museum, and he held that every subject of the Queen, in these islands or in the colonies, and every visitor to this country, must feel that he was benefited by the existence of that museum and by the splendid arrangement of its contents.

Prof. Huxley, in seconding the resolution, said that, if he mistook not, there were very few men living who had had occasion to follow the work of the remarkable man whose career they had met to celebrate with more carefulness and attention than he had done. It was a career remarkable for its length, for the rapid rise to eminence, and the long retention of high position of the person who was the subject of it. It was more than forty years ago since he, as a young man, had occasion to look abroad upon the scientific world of London, in which he was then a complete novice, and to see whether, perhaps, in some small and insignificant corner of it room might be found for him. At that time there were four persons whose names stood out amongst the first in the galaxy of scientific men of this country. They were Sir John Herschel, Mr. Faraday, Sir Charles Lyell, and, last, though by no means least, the famous Hunterian Professor, Owen. If he looked abroad amongst the lights of biological science, with which he was principally concerned, there were Johannes Müller in Berlin, Milne Edwards in Paris, Von Baer in St. Petersburg; but for quantity, general excellence, and variety of work there was no one who could be regarded as the superior of Owen. It was a common impression that Owen was the successor and continuator of Cuvier, and that was largely true. The memoirs on the pearly nautilus, on the marsupials, on the anthropoid apes were fully worthy of the author of the "Memoires sur les Mollusques" or the "Leçons d'Anatomie Comparée," while the "Ossemen fossies" had a full equivalent in the vast series of papers upon fossil remains, contained in the publications of the Royal, the Geological, and the Palæontographical Societies. But it was also to be remembered that, in another field, Owen was the successor and continuator of the school to which Cuvier was most vehemently opposed—that of St. Hilaire and Oken. The remarkable contributions to morphology embodied in the works on the archetype of the vertebrate skeleton and on the nature of limbs were able developments of speculative views of another order than Cuvier's. Readers of Goethe would remember that he thought the news of the controversy between Cuvier and St. Hilaire far more interesting than that of the Revolution of July, which broke out about the same time. Whether that was a just estimate of the relative importance of things or not might be left an open question; but it was the peculiar irony of history to show us in so many quarrels that right and wrong were on both sides. And in this particular controversy it had turned out that the right lay neither with Cuvier nor with St. Hilaire, but partly with both and partly with a third party, which at that time hardly existed. Whatever might be the ultimate verdict of science in this particular matter, there could be no doubt that it was a distinct aid to progress to have one view of the case stated and illustrated with the unrivalled wealth of knowledge which Owen brought to bear upon it. If history confirmed, as he believed it would, the estimate of the broad features of Sir Richard Owen's work, which he had suggested, then it would justify them in endeavouring to preserve the memory of the great results achieved by his stupendous powers of work, his remarkable sagacity in interpretation, and his untiring striving towards the ideal which he entertained.

The resolution was then put and agreed to unanimously, as were also those which followed.

The Duke of Teck moved:—"That the memorial shall consist primarily of a marble statue which shall be offered to the Trustees of the British Museum to be placed in the hall of the Natural History Museum." His Royal Highness said,—There is no doubt, in my mind at least, that this would be the most appropriate place and the most appropriate form in which to erect the likeness of our admired friend. It is, so to say, his second home, the home of his later labours, and no better place could be found. Besides, I think it is a very nice idea that every one who enters the hall should see first of all the man to whom we owe this inheritance. Others have said so much about Sir Richard Owen that it is needless for me to go over the ground again. As all of us know so well, what he has been and what he has done will remain in the minds of all who survive him, and, therefore, I will only say that in my opinion the hall, which is a very fine interior, of the Natural History Museum should be the place where the memorial of this great man should be erected.

Sir William Flower, in seconding the resolution, said that having twice in his life succeeded Sir Richard Owen, he had had special opportunities of judging of his work, and he might, therefore, be expected to say something about the general character and extent of that work on the present occasion, but after what had been said in the introductory remarks of His Royal Highness, and the speech of Prof. Huxley, than whom no one

was more competent to give an opinion upon the scientific side of the question, there was no necessity for doing so. He could not refrain, however, from speaking upon one point. Among the various characteristics of Sir Richard Owen, one of the most remarkable was his untiring industry, which enabled him to produce an amount of work which was truly prodigious. It could hardly be expected that such a vast series of memoirs on so many diverse subjects, as that which he had given forth to the world during his long life, could all be equal in quality, or that the merits of some of them should not have been the occasion of controversy. He would only refer to one instance of this kind. As long ago as 1837, Sir R. Owen read a paper before the Society in whose rooms they were now assembled, which was published in the Philosophical Transactions, and in which certain remarkable characteristics were stated to exist in the brain of marsupial animals, widely distinguishing them from other members of the class to which they belong. The conclusions apparently established by this paper were generally accepted for nearly thirty years, but in 1865 another memoir was read before the same society, and also published in the Philosophical Transactions, in which a different view was taken both of the nature of the structural peculiarities and of their significance in classification. The views of the author of this second paper have generally found favour until within a few months since, when an independent investigation of the subject, carried on with all the improved methods of modern research, by Dr. J. Symington, has resulted in a declaration in favour of the accuracy of Owen's original description and conclusions. These observations may still require confirmation by others, but as he (Sir W. Flower) was the author of the second paper, he considered it only fitting that he should, at a meeting assembled to do honour to the memory of the great anatomist, from whom, on this point, he had differed so long, call attention to them. He thought this the best contribution he could make to the object for which they had gathered together.

Dr. P. L. Sclater suggested that, in addition, a memorial catalogue of the late professor's writings should be issued, with a portrait and biographical memoir.

Sir James Paget moved that a committee be formed to carry out the preceding resolutions. It would be impossible, he said, to have any better evidence that the resolutions just passed were right than the number and position of those who had offered to serve on the committee, for there was never a more representative list. Headed by the Prince of Wales, the Duke of Teck, the Archbishop of Canterbury, and the Lord Chancellor, it contained nearly 150 of the most prominent workers in all branches of science and many who were the best judges of the influence of science on the general well-being of the nation. He was the oldest person present who had worked with Sir R. Owen, and could remember him on entering St. Bartholomew's Hospital as a student in 1834. He could testify to the influence Owen had exercised in promoting the study of science by showing to all around him how keen his delight was in it, and how in itself alone it might be a sufficient reward. He resisted all temptations to leave science, though he might have been a very successful medical practitioner; and he was one of the first by whom the real reform of sanitary matters was begun in this country.

Sir J. Evans briefly seconded the motion.

Sir A. Clark moved—"That the following list of gentlemen constitute the executive committee: His Royal Highness the Prince of Wales (chairman), His Serene Highness the Duke of Teck, the President of the Royal Society, the President of the Royal College of Physicians, the President of the Royal College of Surgeons, the President of the Linnæan Society, the President of the Zoological Society (treasurer), Sir John Evans, Prof. Michael Foster, Dr. A. Günther, Prof. Huxley, Sir F. Leighton, Sir James Paget, Dr. P. L. Sclater, Mr. W. Percy Sladen (secretary), Lord Walsingham, Mr. A. Waterhouse, R.A., and Mr. Henry Woodward." Sir Andrew remarked that this memorial movement reminded them that nations no more than individuals can live by bread alone. Material prosperity did not constitute the true abiding life of a nation; it was necessary that it should live by ideas: and the nation honoured those who, like Owen, communicated new ideas which spurred others to new courses of activity.

Mr. T. Bryant, in seconding the motion, said the College of Surgeons felt the loss that science had sustained in the death of him who unquestionably was the grand expounder of John Hunter and who, more than any one else, demonstrated the value of the materials John Hunter left behind him. He did more than any one else to call the attention of the scientific world to the museum in Lincoln's Inn, and by additions to it to make it what it is. More than that, at a time when comparative anatomy and biological studies were little thought of he called attention to the value of them, the necessity for them, and the pleasures they would yield. As a young man he attended Owen's lectures, and felt the full force of his quiet enthusiasm, which was altogether independent of the materials embodied in the lectures.

Lord Playfair, in supporting the motion, said that he was the last surviving member of the Health of Towns Commission of 1844, upon which he was brought into continual intercourse with Sir R. Owen, and therefore he knew how much Sir Richard had at heart the advancement of sanitary science. This interest in it he maintained throughout his whole career. He lived close to Sir Edwin Chadwick, and although no two men could be more unlike, they were most intimate friends, and were constantly discussing how to advance the health of the nation. When Sir Richard returned from his interesting expedition to Egypt he told the speaker that he had come back in an unforgiving spirit towards Moses, because though skilled in the learning of the Egyptians, and having derived his chief commandments from those of that ancient race, he missed one important one, "Thou shalt not pollute rivers." Owen, like Prof. Huxley, exercised great influence outside the domain of science. Prof. Huxley had benefited the education of the country, and Prof. Owen had considerable influence in improving the sanitary condition of the country.

Sir W. Flower read a first list of donations, headed with one of £25 by the Prince of Wales.

Sir Henry Acland moved, and Prof. Michael Foster seconded, a vote of thanks to his Royal Highness for consenting to become chairman of the committee, and for presiding on the present occasion.

The Prince of Wales, in responding, said,—I beg to return my warmest thanks to my kind and valued old friend, Sir Henry Acland, for the way he has proposed, to Mr. Michael Foster for the way in which he seconded, and to you all for the kind manner in which you have received this resolution. It has indeed been a labour of love to me to-day to preside on this very interesting occasion, and I think that it has seldom been my good fortune to listen to more interesting or eloquent addresses than those which have fallen from the lips of those eminent gentlemen who have spoken. Nobody will take a deeper interest in the carrying out of this memorial of our lamented friend Sir Richard Owen than myself, and most sincerely do I hope that the great work that is to adorn the Natural History Museum will be worthy of a great sculptor and of the great man that it represents.

SCIENTIFIC SERIALS.

Bulletin de l'Académie Royale de Belgique, Nos. 9 and 10. Classe des Sciences.—On some new *Caligidei* of the coast of Africa and the Azores Archipelago, by P. J. van Beneden.—On an optical atmospheric phenomenon observed in the Alps, by F. Folie (see Notes).—On a state of matter characterised by the mutual independence of the pressure and the specific volume, by P. de Heen. It is easily shown that the density of saturated vapour at the critical temperature is variable, and depends, at constant pressure, upon the proportion of liquid enclosed in the tube. Experiments were made in order to decide whether this independence of pressure and volume was shown also at other temperatures. The liquid chosen was ether, and the volume of liquid and vapour contained in a sealed tube was read by means of a cathetometer. A series of results showed that during condensation by pressure the density of unsaturated vapour was greater than that of saturated vapour, or that the specific volume increased with the pressure. This is an experimental verification of Prof. James Thomson's pseudo gaseous state of matter.—On the most complete reduction of invariant functions, by Jacques Deruyts.—Ex-meridian observations made at the Royal Observatory of Belgium from March to October, 1892, by L. Niesten and E. Stuyvaert.—On a new fluorine-derivative of carbon, by Frédéric Swarts. This is a liquid, of the formula CCl_3F, boiling at 24°·7, insoluble in water, and unaffected by sulphuric and nitric acids. Its density is 1·4944; an alcoholic solution of

potash destroys it gradually, forming potassium chloride, fluoride, and carbonate. It was obtained by treating carbon tetrachloride with a mixture of antimony trifluoride and bromine in equal molecular proportions. It is notable that the bromofluoride produced by the mixture acts not as a bromising but a fluorising agent.—On a simplification of some of Tesla's experiments, by H. Schoentjes. Like some recent workers in England, Prof. Schoentjes has found that most of the experiments can be produced, although with lesser intensity, without the bobbin immersed in oil, the discharge exciter, and the condenser, simply by the first Rhumkorff coil, whose dimensions need not exceed 7 × 17 cm.—On a process of sterilisation of albumin solutions at 100° C., by Émile Marchal. Albumin can be easily sterilised at 100° C., without coagulation, by first adding 0·05 gr. per litre of borax, or 0·005 of ferrous sulphate in a 2 to 5 per cent. solution, or 4 to 5 gr. nitrate of urea per litre of 10 per cent. solution. The "incoagulable albumin" thus obtained is perfectly suitable for cultivations.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 24, 1892.—"Memoir on the Theory of the Compositions of Numbers," by P. A. MacMahon, Major R.A., F.R.S.

In the theory of the partitions of numbers the order of occurrence of the parts is immaterial. Compositions of numbers are merely partitions in which the order of the parts is essential. In the nomenclature I have followed H. J. S. Smith and J. W. L. Glaisher. What are called "unipartite" numbers are such as may be taken to enumerate undistinguished objects. "Multipartite" numbers enumerate objects which are distinguished from one another to any given extent; and the objects are appropriately enumerated by an ordered assemblage of integers, each integer being a unipartite number which specifies the number of objects of a particular kind; and such assemblage constitutes a multipartite number. The 1st Section treats of the compositions of unipartite numbers both analytically and graphically. The subject is of great simplicity, and is only given as a suitable introduction to the more difficult theory, connected with multipartite numbers, which is developed in the succeeding sections.

The investigation arose in an interesting manner. In the theory of the partitions of integers, certain partitions came under view which may be defined as possessing the property of involving a partition of every lower integer in a unique manner. These have been termed "perfect partitions," and it was curious that their enumeration proved to be identical with that of certain expressions which were obviously "compositions" of multipartite numbers.

The generating function which enumerates the composition has the equivalent forms—

$$\frac{h_1 + h_2 + h_3 + \dots}{1 - h_1 - h_2 - h_3 - \dots},$$

$$\frac{a_1 - a_2 + a_3 - \dots}{1 - 2(a_1 - a_2 - a_3 - \dots)},$$

where h_s, a_s represent respectively the sum of the homogeneous products of order s and the sum of the products s together of quantities

$$\alpha_1, \alpha_2, \alpha_3, \dots, \alpha_n,$$

and the number of compositions of the multipartite

$$\overline{p_1 p_2 \dots p_n}$$

is the coefficient of $\alpha_1^{p_1}\alpha_2^{p_2}\dots\alpha_n^{p_n}$ in the development according to ascending powers.

It is established that

$$\frac{1}{2}\,\frac{1}{\{1 - s_1(2\alpha_1 + \alpha_2 + \dots + \alpha_n)\}\{1 - s_2(2\alpha_1 + 2\alpha_2 + \dots + \alpha_n)\}\dots\{1 - s_n(2\alpha_1 + 2\alpha_2 + \dots + 2\alpha_n)\}}$$

is also a generating function which enumerates the compositions; the coefficient of

$$s_1^{p_1}s_2^{p_2}\dots s_n^{p_n}\alpha_1^{p_1}\alpha_2^{p_2}\dots\alpha_n^{p_n}.$$

being the number of compositions possessed by the multipartite

$$\overline{p_1 p_n \dots p_n}.$$

The previous generating function may, by the addition of the fraction $\frac{1}{2}$ and the substitution of $s_1\alpha_1$, $s_2\alpha_2$, &c., for α_1, α_2, &c., be thrown into the form

$$\frac{1}{2}\,\frac{1}{1 - 2(\Sigma s_1\alpha_1 - \Sigma s_1 s_2\alpha_1\alpha_2 + \dots (-)^{n+1}s_1 s_2 \dots s_n\alpha_1\alpha_2\dots\alpha_n)},$$

and hence these two fractions, in regard to the terms in their expansions which are products of powers of $s_1\alpha_1$, $s_2\alpha_2$, …, $s_n\alpha_n$, must be identical. This fact is proved by means of the identity—

$$\frac{1}{2}\,\frac{1}{\{1 - s_1(2\alpha_1 + \alpha_2 + \dots + \alpha_n)\}\{1 - s_2(2\alpha_1 + 2\alpha_2 + \dots + \alpha^n)\}\dots\{1 - s_n(2\alpha_1 + 2\alpha_2 + \dots + 2\alpha_n)\}}$$

$$= \frac{1}{2}\,\frac{1}{1 - 2(\Sigma s_1\alpha_1 - \Sigma s_1 s_2\alpha_1\alpha_2 + \dots (-)^{n+1}s_1 s_2 \dots s_n\alpha_1\alpha_2\dots\alpha_n)}$$

multiplied by

$$1 + \Sigma\frac{2(A_{\kappa_1} + \alpha_{\kappa_1})\dots(A_{\kappa t} + \alpha_{\kappa t}) - (A_{\kappa_1} + 2\alpha_{\kappa_1})\dots(A_{\kappa t} + 2\alpha_{\kappa t})}{(1 - S_{\kappa_1})\dots\dots\dots(1 - S_{\kappa t})}s_{\kappa_1}s_{\kappa_2}\dots s_{\kappa n},$$

where

$$S_\kappa = s_\kappa(2\alpha_1 + \dots + 2\alpha_\kappa + \alpha_{\kappa+1} + \dots + \alpha_n) = s_\kappa(A_\kappa + 2\alpha_\kappa),$$

and the summation is in regard to every selection of t integers from the series

$$1, 2, 3, \dots n,$$

and t takes all values from 1 to $n - 1$.

This remarkable theorem leads to a crowd of results which are interesting in the theory of numbers.

The geometrical method of "trees" finds a place, and, lastly, there is the fundamental algebraic identity—

$$\frac{1}{k}\,\frac{1}{\{1 - s_1(k\alpha_1 + \alpha_2 + \dots + \alpha_n)\}\{1 - s_2(k\alpha_1 + k\alpha_2 + \dots \alpha_n)\}\dots\{1 - s_n(k\alpha_1 + k\alpha_2 + \dots + k\alpha_n)\}}$$

$$= \frac{1}{k}\,\frac{1}{1 - k\Sigma s_1\alpha_1 + k(k-1)\Sigma s_1 s_2\alpha_1\alpha_2 - \dots + (-)^n k(k-1)^{n-1}s_1 s_2\dots s_n\alpha_1\alpha_2\dots\alpha_n}$$

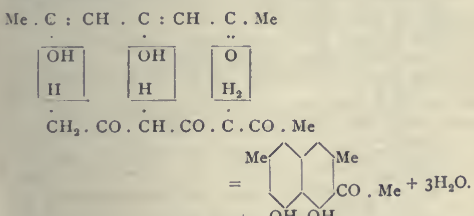
multiplied by

$$1 + \Sigma\frac{k(A_{t_1} + \alpha_{t_1})\dots(A_{t_n} + \alpha_{t_n}) - (A_{t_1} + k\alpha_{t_1})\dots(A_{t_n} + k\alpha_{t_n})}{(k-1)(1 - S_{t_1})(1 - S_{t_2})\dots(1 - S_{t_n})}s_{t_1}s_{t_2}\dots s_{t_n},$$

which reduces to that formerly obtained when k is given the special value 2.

Chemical Society, December 13.—Mr. W. Crookes, Vice-President, in the chair.—The Stas Memorial Lecture, by J. W. Mallet, was read (see this vol. p. 248).

December 15.—Dr. W. J. Russell, Vice-President, in the chair.—The following papers were read:—The identity of caffeine and theine and the interactions of caffeine and auric chloride, by W. R. Dunstan and W. F. J. Shepheard. Various physiologists have concluded that differences exist between theine from tea and caffeine from coffee; the authors have compared the products from the two sources, and consider that their identity is beyond question. The differences in physiological action observed by Mays, Brunton, and Cash can only mean that the alkaloids employed were either impure or administered under non-comparable conditions. On heating an aqueous solution of caffeine aurichloride, a yellow precipitate of aurochlorocaffeine $C_8H_9(AuCl_2)N_4O_2$ separates; the production of this substance is better explained by Medicus' formula for caffeine than by that of E. Fischer.—Studies on isomeric change, ii. Orthoxylenesulphonic acids, by G. T. Moody. 1 : 2 : 3-orthoxylenesulphonic acid, when heated at 115–120° in a current of dry air, undergoes quantitative conversion into the isomeric 1 : 2 : 4-sulphonic acid. The former acid is prepared by sulphonating dibromorthoxylene and reducing the resulting dibromorthoxylenesulphonic acid with zinc dust and sodium hydroxide. A number of derivatives are described.—Studies on isomeric change, iii. Phenetoilsulphonic acids, $C_6H_4(OEt)SO_3H$, by G. T. Moody. Bromophenetoilsulphonic acid, prepared by ethylating parabromophenol and sulphonating the bromophenetoil so obtained, is readily reduced by zinc dust and sodium hydroxide with formation of orthophenetoilsulphonic acid. The latter is completely converted into the isomeric parasulphonic acid on heating for several hours at 100°. Lagai's observations, contradicting the author's previous results, are shown to be erroneous.—Formation and nitration of phenyldiazoimide, by W. A. Tilden and J. H. Millar. Phenyldiazoimide, $N_3.Ph$, is readily obtained by the interaction of nitrosyl chloride and phenylhydrazine in glacial acetic acid solution; on nitration it yields about two-thirds of its weight of the paranitro-derivative (m.p. 74°). Nitrophenyldiazoimide is a convenient source from which to prepare diazoimide.—The production of naphthalene derivatives from dehydracetic acid, by J. N. Collie. The author concludes that the yellow substance which he has previously obtained by the condensation of diacetylacetone (see this vol. p. 238) is probably formed in accordance with the following equation:—



This substance gives a diacetyl derivative which on distillation with zinc dust yields a trimethylnaphthalene. The condensation product closely resembles the acetonaphthols prepared by Wilt and Erdmann.—A new synthesis of hydrindone, by F. S. Kipping. Contrary to the statement of Hughes, hydrindone may be easily prepared in large quantities by the action of aluminium chloride on phenylpropionic chloride; 50–60 per cent. of the theoretical yield is obtained, the reaction being represented by the following equation: $Ph . CH_2 . CH_2 . COCl = Ph\left\langle\begin{matrix}CH_2\\CO\end{matrix}\right\rangle CH_2 + HCl$. The ketone prepared in this way is identical with that obtained from other sources by several chemists; its hydrazone, hydroxime and a nitro-derivative are described. On heating hydrindone with moderately concentrated sulphuric acid a condensation product, $C_{18}H_{14}O$, is obtained; it forms yellowish plates melting at 141·5–142·5°. Phosphoric anhydride converts hydrindone into a yellow crystalline substance, which is apparently identical with the hydrocarbon of the empirical composition C_9H_6, which the author has previously obtained by the action of phosphoric anhydride on phenylpropionic chloride.—The resolution of methoxysuccinic acid into its optically active components, by T. Purdie and W. Marshall. Synthetical methoxysuccinic acid can be resolved into its optically active constituents by crystallisation of the acid cinchonine salts, the salt of the dextro-acid being less soluble in water than that of its lævo-isomeride. The separation effected in this way is, however, only partial, the metallic salts obtained after removal of the alkaloid being a mixture of the active and inactive compounds; by taking advantage of the fact that the inactive calcium or acid potassium salt is less soluble in water than its active isomeride, the optically active acids may be isolated. The active acids have a specific rotatory power of about 33° in 5–10 per cent. aqueous solutions and melt at 88–90°, whilst the inactive acid melts at 108°. The rotation of the normal ammonium or potassium salt is of the same sign as that of the parent acid; the rotation of the calcium or barium salt is of opposite sign to that of the acid, but varies greatly with change of concentration. The rotation of the barium salt changes sign in very dilute solutions.—Optically active ethoxysuccinic acid, by T. Purdie and I. W. Walker. If fed with nutritive mineral salts the spores of *Penicillium glaucum* flourish in a solution of inactive hydrogen ammonium ethoxysuccinate and consume the lævogyrate acid, leaving the dextro-acid unaltered. On crystallising the cinchonidine salt of the inactive acid, a separation into the lævo- and dextro-modifications may be effected, and the oppositely active acid ammonium salts prepared in this way resemble that obtained by means of *Penicillium glaucum*. Close parallelism exists between the methoxy- and ethoxy-succinates, with respect to optical activity.—The formation of benzyldihydroxypyridine from benzylglutaconic acid, by S. Ruhemann. Ethyl benzylglutaconate slowly dissolves at 100° in concentrated aqueous ammonia, yielding a solution, from which acids separate benzyldihydroxypyridine. This substance exhibits both basic and acid properties and melts at 184°.—The action of nitrous acid on 1-α-amido-2-β-naphthol; a correction, by R. Meldola. The author agrees with the statement of Grandmougin and Michel that β-naphthaquinone results from the interaction of nitrous acid and 1-α amido-2-β-naphthol.—Note on the action of phenylhydrazine on mono- and di-carboxylic acids at elevated temperatures, by W. R. Hodgkinson and A. H. Coote. On distilling a mixture of phenylhydrazine and phenylacetic acid in equivalent proportion, benzene, aniline and a liquid of the composition $C_{14}H_{12}O_2$ distil over; nitrogen and ammonia are also evolved. As has been previously shown, the hydrazide of the composition $Ph . CH_2 . CO . NH . NH . Ph$ is the first product of the reaction; on distilling this substance, NH . NH is split off, and reduces the phenylhydrazine present to aniline and benzene. Somewhat similar reactions occur in the cases of orthotoluic, phenylpropionic, and succinic acids, and are now under investigation.

SYDNEY.

Royal Society of New South Wales, September 7, 1892.—Prof. Warren, President, in the chair.—Paper read: The effect which settlement in Australia has produced upon the indigenous vegetation, by A. G. Hamilton [Part I.].

October 5.—Prof. Warren, President, in the chair.—The second part of paper on the effect which settlement in Australia has produced upon indigenous vegetation, by A. G. Hamilton, was read, after which the society's bronze medal and a cheque for £25 were presented to the author.

November 2.—Prof. Warren, President, in the chair.—Dr. William Huggins, F.R.S., was elected an honorary member of the Society. The following papers were read:—Preliminary note on limestone occurring near Sydney, by H. G. Smith.—On a cyclonic storm near Narrabri, by H. C. Russell, F.R.S.—Some folk-songs and myths from Samoa, translated by the Rev. G. Pratt, with introduction and notes by Dr. John Fraser.

PARIS.

Academy of Sciences, January 16.—M. de Lacaze-Duthiers in the chair.—Swimming movements of the ray-fish, by M. Marey. These were investigated by means of chronophotography, ten exposures being made per second. The fish was fixed in position by the head and tail, and the views were taken from the front and the side respectively, the fins being left free

to move. The photographs show the successive phases of one entire motion of the fins, which consists of a wave-like motion beginning in front. Shortly after the anterior portion has been lifted it is depressed, the motion being meanwhile propagated to the lateral portions, and growing in amplitude as the fin grows in breadth. Just before the movement dies out near the tail the process recommences in front. The periodic time was 0·8 seconds. The photographs show a striking likeness to those obtained by chronophotography applied to the flight of birds. M. Marey intends to study the mechanical effect of the action of the fins upon the water, also by the aid of photography.—Microscopic researches on the contractility of the blood-vessels, by M. L. Ranvier. The periœsophagian membrane of the frog was placed on the disc of the slide-cell in one or two drops of peritoneal serum. It was kept extended by a platinum ring; electrodes of tinfoil were placed in connection, and a cover glass was fixed over the whole with paraffin. Thus mounted, the smooth muscular fibres and the internal elastic sheath are well seen. On connecting the induction coil with the electrodes, the muscular fibres contract as soon as the current is strong enough. At the same time, the folds of the internal sheath become more pronounced and finally touch, thus effacing the passage through the small artery. On breaking the current, the artery gradually regains its original diameter. If the current is not sufficiently strong for producing a regular contraction, some of the segments contract, while others are at rest. But the zone of contraction is never displaced, and, if interrupted, will reappear at the same place on reestablishing the current. Nothing corresponding to a peristaltic motion can be produced by direct electrical excitement. In none of the experiments, even with the strongest currents, was it possible to detect any signs of contraction in the capillaries.—On the sum of the logarithms of the first numbers not exceeding x, by M. Cahen.—On differential equations of a higher order, the integral of which only admits of a finite number of determinations, by M. Paul Painlevé.—On linear differential equations with rational coefficients, by M. Helge von Koch.—Electric waves in wires; depression of the wave propagated in conductors, by M. Birkeland (see *Wiedemann's Annalen*, abstract).—On the minimum perceptible amount of light, by M. Charles Henry. This was estimated by Aubert at $\frac{1}{300}$th of the light of the full moon. This is about a thousand times too great, as proved by some measurements made with the zinc-sulphide (phosphorescence) photometer previously described. The corrected formula for the rate of loss of luminosity of the sulphide is $i^{0\cdot5}(t-18\cdot5)=1777\cdot8$, which agrees even with the longest observations, and is theoretically justified by M. Henri Becquerel. The minimum perceptible amount of light was determined by noticing the time at which the eye, previously kept in the dark for one hour, could only just distinguish the light emitted by the phosphorescent substance, taking care to test for illusions by the successive interposition of ground-glass screens. The time thus found was four hours, giving an amount of light of 29×10^{-9} standard candles at 1 m. If the eye is previously kept in the dark during varying periods, the minimum varies inversely as the square of the time during which it is kept dark.—On phosphorescent sulphide of zinc, considered as a photometric standard, by the same. Careful tests showed that the light emitted by zinc sulphide at a given instant is independent of the distance of the illuminating magnesium ribbon, of the time of illumination, and of the thickness of the layer, and is also uniform in samples prepared under different conditions, thus exhibiting all the requisites of a secondary photometric standard.—On an acid plato-nitrite of potassium, by M. M. Vèzes.—Decomposition of chloroform in presence of iodine, by M. A. Besson.—On some ethers of homopyrocatechine, by M. H Cousin.—On the determination of phosphorus in iron and steel, by M. Adolphe Carnot. The new method, based like most others on the employment of ammonium molybdate, differs from them in the mode of separation of the silicon, which is effected by sulphuric acid; in the process of destruction of the carbon compounds, brought about by chromic acid; and in the nature of the final compound, which is not magnesium pyrophosphate, but dry phosphomolybdate of ammonia, which only contains 1·628 per cent. of phosphorus, thus ensuring a greater accuracy in the quantitative estimation.—Losses of nitrogen in manure, by MM. A. Muntz and A. Ch. Girard.—Researches on the localisation of the fatty oils in the germination of seeds, by M. Eugène Mesnard. It appears that, except in the grasses, the fatty oil is not specially localised. It is in all cases independent of the starch and the glucose, but it appears superposed upon the albuminoid materials in the reserves of ripe seeds.

BERLIN.

Physical Society, December 16, 1892.—Prof. Kundt, President, in the chair.—Dr. Lummer spoke on the principles involved in the use of half-shade polarimeters. He showed that the difference in brightness of the two halves of the field of the instrument depends first on the angle between the two polarising prisms, the less this is the greater being the difference produced by a minimal rotation of the analyzer, and secondly on the power of perceiving minute differences of brightness. In connection with the latter he had made some changes in the Lippich instrument which presented some distinct advantages.—Prof. Goldstein gave an account of some experiments made many years ago, but not yet published. He first dealt with the light which appears at the anode, and which, as compared with that of the kathode, has as yet been but little investigated. As is well known, a kathode consisting of two metals emits rays of different brightness from its two parts, thus for instance the aluminium emits brighter rays than does the silver. When this electrode is used as an anode, the reverse holds good, inasmuch as the anodic light of silver is brighter than that of aluminium. The difference is, however, only observed in rarefied oxygen, and does not exist in a hydrogen tube, and is hence due to oxidation of the silver. The second set of experiments dealt with Crookes' supposed reciprocatory deflection of kathodic rays of similar direction. The speaker had shown, by shielding one of the electrodes, that the deflection is apparent, not real. The change in the path of the kathodic radiation is due entirely to the effect of the second electrode upon the rays emitted by the first.

CONTENTS.

THURSDAY, FEBRUARY 2, 1893.

TROPICAL AGRICULTURE.

A Text-book of Tropical Agriculture. By H. A. Alford Nicholls, M.D., F.L.S., C.M.Z.S., with illustrations, pp. 312. (London: Macmillan and Co., 1892.)

THIS text-book is the English edition of a work that has already received high commendation from the Government of Jamaica. The Government of this now prosperous colony, in pursuance of a policy (which may well be followed by other colonies) offered a premium of one hundred pounds for the best text-book of Tropical Agriculture adapted for the use of colleges and higher schools in the colony. The award was made to Dr. Nicholls's manuscript, and after the publication of the work in Jamaica it was adopted also as a text-book by the Government of other colonies, so that its value has been practically estimated beforehand. The author's qualifications for the task he has undertaken may be gathered from the following:—

"Twelve years ago, when he had to direct his attention to tropical agriculture, there was no practical book that he could turn to for help in all the difficulties that were constantly cropping up in his path. Knowing, therefore, the obstacles that usually beset the inexperienced planter who is not content to follow the old grooves of unscientific agriculture, the author has so written the second part of this book as to afford the information he needed greatly in his own planting novitiate. This has rendered it necessary to enter into details, which to the experienced agriculturist may appear superfluous, but the book is really intended as a guide to the young and unlearned to whom such details are likely to be of essential service."

As an introduction to tropical agriculture this book supplies a want long felt. There are several works of a technical character treating of old and well-established industries such as sugar, tea, coffee, cacao. None of these, however, could be adopted as text-books in schools. Indeed they all presuppose such a close acquaintance with the principles and terminology of tropical agriculture that they appeal to a very limited class of readers. Hitherto, tropical agriculture, to a large extent, has borrowed most of its methods from the agriculture of temperate climates and adapt them, as well as it could, to the very different circumstances of the torrid zone. The result has been by no means satisfactory. In tropical regions effects follow cause so rapidly that methods admirably adapted to the cold, sluggish climates of northern countries are most injurious when too closely followed in the tropics. As instances we may cite the serious effects on climate following the extensive cutting down of forests, and the wholesale washing away of surface soil from land under permanent cultivation by the destructive influences of tropical rains. The merit of Dr. Nicholls's book lies in the fact that its precepts are directly based on his own experience, and he appeals so effectively to the intelligence of his readers that they cannot fail to be instructed. The work is divided into two parts:—Part I. deals with the elementary principles of agricultural science and discusses amongst other subjects the origin and composition of soils, the nature of plant life, the controlling influence of climate, the action and constituents of manures, the rotation of crops, the drainage of soils, irrigation, tillage operations, pruning, budding, and grafting. In Part II. there is treated the application of these principles to some of the chief of the various cultivations undertaken in tropical countries. As examples we may mention that there are detailed accounts given of the methods found most successful in the cultivation of coffee, cacao, tea, sugar-cane, fruits, spices, tobacco, drugs, dyes, tropical cereals, and such food plants as cassava, arrowroot, yams, sweet potato, tania (*Colocasia*).

The book is intended also, according to the preface, to be of service to peasant proprietors, owners of small estates, and to those [European] settlers who from time to time may wish to make their homes in the tropics. It is just these people who are now building up the new prosperity of the West Indies by means of what are called "minor industries" or *la petite culture*—which the French have found so remunerative in many of their colonies. To guide and instruct the mass of small cultivators in the West Indies has been the dream of the most enlightened Governors, such as Sir John Peter Grant, Sir Anthony Musgrave, Sir William Robinson, and others that have ruled there for the last thirty years. The intelligent settlers of European origin can very well take care of themselves: but the mass of the small cultivators are black people. They have, it is true, received some education, and they are not wanting in intelligence in regard to what concerns their own interests, but their methods of cultivation have, hitherto, been of the rudest and most destructive description. They crop the land year after year without any manuring, and when it is thoroughly exhausted they move on, when they can, to fresh land, and treat that in exactly the same way. Thus in the black man's system of cultivation the rotation is of land, and not of crops, and the future has to take care of itself. This is a relic of the times of slavery, when the negroes were allowed as much land as they cared for—out of reach of sugar cultivation—to grow provisions for their own subsistence. It is now necessary to change the whole character of the black man's cultural methods, or the rich and fertile lands still left in the West Indies will be absolutely ruined. Generally only the lowest class of negroes have hitherto been attracted to field work. The education given to these people is responsible for something of this result, for it leads them, in too many cases, to regard labour in the field as degrading, and almost a return to a state of slavery. The sharper and more intelligent boys, when they leave school, are drawn away to seek a precarious existence as clerks in stores or as small shopkeepers, where they seldom do more than copy the weaknesses and vices of the whites, while, according to our author, if they took to the land, and had a right understanding of agricultural methods, they "need never despair of becoming prosperous." In the more advanced colonies, such as Jamaica, there is a disposition to establish industrial schools and train the younger generation in approved methods of cultivation, and lead them to regard the tillage of the soil as a more honourable and remunerative occupation than petty trading. We may hope that the claims of industrial education will become more widely recognized, not only in the West Indies but in all our tropical colonies where native races have to be dealt

with. In the meantime colleges and schools must prepare competent instructors for the work, and for both teacher and taught this book is an admirable starting-point. In it the whole field of small industries is well covered, and the language is clearly expressed and well chosen. As an example of the author's treatment we find under manures (p. 49):—

"The land must be regarded by the planter as a bank in which he has opened an account. If he continually draw cheques on the bank, and make no fresh deposit to meet the drain, he will sooner or later come to the end of his capital, and the same argument applies to the soil. In cacao and coffee cultivation in the West Indies, particularly on lands of peasant proprietors, one often sees the planter take away crops year after year, whilst he does next to nothing to make up for the heavy drain on the land; and then, after a time he finds he gets very small crops, and he thinks the fault lies with the trees, or that the soil is not adapted to the cultivation, whereas the fault is entirely his own, as he has gone on taking away from the soil without putting anything back." Again, "the great fault hitherto committed by tropical planters has been the confining of their attention to one kind of cultivation on their land. If several different crops were taken off alternately, as in a system of rotation, or grown in different parts of the land, where the soil and climate prove suitable, the planter would be in a much better position than he is now, for he would not 'have all his eggs in one basket.'"

It is noticed that the valuable services rendered to colonial industries by Kew and by the various botanical institutions in correspondence with Kew are fully recognised. Further, the dedication of this first Text-book of Tropical Agriculture to Sir Joseph Hooker is a compliment not only to his own distinguished services, but also to those of his father, for both in their day took the deepest interest in the West Indies. It must be gratifying to the late Director of Kew to learn "in the quiet of his retirement that the influence of his work lives on and bears fruit even in the far-away field" of the West Indies.

D. M.

CELLS: THEIR STRUCTURE AND FUNCTIONS.

Die Zelle und Die Gewebe, Grundzüge der allgemeinen Anatomie und Physiologie. Von Prof. Dr. Oscar Hertwig. (Jena: Gustav Fischer, 1892.)

TEXT-BOOKS on Histology introduce the structure of the tissues to their readers by a chapter on cells, and the best treatises on Anatomy, either human or comparative, usually devote some pages to the consideration of these, the most elementary of all the tissues. As so many important advances have been made of late years in our knowledge of the structure of cells and their contained nuclei, of the properties of protoplasm, of the division of nuclei and the part played by the nucleus in cell multiplication, and of the influence exercised by cells in the problems of hereditary transmission, the time has obviously arrived for the production of a treatise devoted to the description of the cell in its various aspects, observational as well as speculative. No better expositor of the subject in all its bearings could be found than Prof. Oscar Hertwig, who has himself conducted important investigations on this branch of anatomy. The book now before us treats of the general anatomy and physiology of cells, and is to be followed by a second volume, in which the origin and physiological properties of the tissues are to be expounded, as well as their structure.

After a sketch of the history of the cell theory and of the theory of protoplasm, in which, as is too often the case in German text-books, the names of British observers and authors are conspicuous by their absence, he defines a cell to be a little clump of protoplasm which incloses a specially-formed constituent, the nucleus; a definition which accords with those previously made by Leydig and Max Schultze. He then describes at considerable length the characters of protoplasm, both anatomical and physiological, and the chemico-physical and morphological properties of the nucleus. In a short section he discusses the question, Do elementary organisms exist without nuclei? *i.e.* Can you have little clumps of non-nucleated protoplasm pursuing an independent life? As is well known, Haeckel described organisms of this simple character, as cytodes, and gave Monera as an example; but Hertwig is disposed to think that such non-nucleated organisms have not been definitely demonstrated in the animal kingdom, and he quotes Bütschli's observations, which seem to show that even in such micro-organisms as Bacteria a differentiation of a nucleus from surrounding protoplasm can be distinguished.

Two important chapters are written on the movements of protoplasm, of cilia, of flagella, of spermatozoa, on contractile vesicles, and on the irritability of protoplasm under the stimulus of heat, light, electricity and several kinds of mechanical and chemical irritants. The fifth chapter is devoted to the consideration of the nutritive changes and formative activity in cells. Illustrations are given of the power possessed by certain unicellular organisms of taking into their substance and digesting solid bodies of various kinds, and an account is appended of the important observations of Metschnikoff on phagocytosis.

Chapters six and seven are occupied with a description of the multiplication of cells, their mode of division, and the method of fertilization. The process of karyokinesis is described at some length and in its various phases, in clear and precise language, and with an amount of illustration which enables the reader to follow without difficulty this complicated process. The influence exercised by the nucleus, and the part which it plays in the process of cell multiplication, has now been put by the labours of many investigators on a basis of observation, both as regards plants and animals, such as cannot be controverted, and the accuracy of the generalization made half a century ago, both by Martin Barry and John Goodsir, that young cells originate through division of the nucleus of a parent cell, has been amply established.

Dr. Hertwig also recites observations which seem to show that the nucleus does more than act as a reproductive centre within the cell, but also takes a part in cell nutrition. This function of the nucleus was also contended for by Goodsir, but during the period when protoplasm was regarded as the essential element in nutrition or secretion, the claim of the nucleus to take any share in this phase of cell activity was summarily put aside. Recent observations have, however, shown that

clumps of protoplasm, removed from either a unicellular plant or animal, in which no nucleus is present, although capable of living, and retaining their irritability and power of movement for some time, yet neither grow, nor form a cell membrane, nor have the same power of digesting bodies introduced into their substance, as is possessed by a clump of protoplasm which has retained the nucleus. The nutritive activity of the protoplasm would appear, therefore, to be under the influence of the nucleus.

The volume concludes with a chapter on the cell in its relation to theories of heredity. The author, as is now the prevailing opinion amongst biologists, contends that the nucleus is the conveyer of hereditary properties, and that the offspring is a mixed product of both its parents, derived from the ovum and the sperm cell. In the course of this chapter he discusses the views of Darwin, Spencer, Nägeli, Weismann, and De Vries, and suggests the employment of the term "Idioblasts" for the minute elementary particles, which Darwin called "gemmules" in his hypothesis of pangenesis, and which he conceived to be capable of transmitting hereditary characters to succeeding generations.

THEORETICAL MECHANICS.

Elementary Mechanics of Solids and Fluids. By A. L. Selby, M.A. (Oxford: Clarendon Press, 1893.)

AT a period when we are bound to recognize the influence exerted by the examinations of the various educational institutions and of those controlled by other more or less influential examining bodies, we may be excused, on the arrival of a new work, for stating whether or not, and to what extent, it is adapted to their requirements. The book before us does not appear to have been intentionally written for examination purposes, and perhaps on this account it will be all the more welcome. Its purpose, however, is very distinct. It is intended for those students who are desirous of reading mechanics as an introduction to a study of physics. So far, therefore, as its suitability for examinations is concerned, we can heartily recommend it to those who wish to qualify in this particular branch of science, while at the same time it will be read with great benefit by that class of students who desire a thorough knowledge of the portions generally included under the head of Theoretical Mechanics.

In the study of such subjects as the book treats of, the amount of knowledge which the reader may have of mathematics will, to a considerable extent, be a measure of his success. The author expresses a hope that an acquaintance with the elements of algebra and geometry will suffice; but, while not wishing to reduce the usefulness of the book, but rather to direct it into proper hands in which it will be read with greater advantage, we think it would be nearer the mark to say that a thorough knowledge of elementary algebra and a considerable acquaintance with elementary trigonometry are necessary. Certainly the definitions of the trigonometrical ratios will be found in an appendix, but it will be far better if the student has lived with and used these for some time.

Possessing these requirements, he will appreciate and even admire the broad, yet concise nature of the treatment generally; and with regard to this matter we may say that we are unacquainted with any elementary text-book better calculated to create a desire for precise and full ideas. That this is requisite for a study of physics perhaps more than any other subject, no one will deny.

The first chapter of the book is occupied with a consideration of Kinematics, and in it will be found a careful exposition of the displacement, velocity, and acceleration to which a body may be subjected, due attention being drawn to what is necessary for a full representation of them. The appendix following this contains some geometrical theorems and definitions for subsequent use. Then follow the usual chapters on the laws of motion, work, and energy, centre of gravity, moments of inertia, and simple machines. A chapter on gravitation will be read with interest, preceded as it is by an explanation of some of the geometrical properties of the ellipse. Kepler's laws of planetary motion are dealt with, in addition to other relevant matters which do not usually find their way into elementary text-books.

The subject of elasticity also receives a somewhat more extensive treatment than is usually given to it. The various kinds of stress and strain which a body may undergo are explained, together with the relation between stress and strain. At the end of the book we find what is included under the second head of the title. The various principles and laws which refer to fluids, and some of the machines and instruments which depend on them for their action, are enumerated and explained, while the interesting subject of capillarity has a separate chapter devoted to it.

To an appreciative reader it is a source of satisfaction to observe the care the author has exercised when dealing with the important matter of definitions and units—fundamental and derived. A chapter on units and their dimensions is furnished at the end.

A good selection of examples, bearing on the matter treated therein, will be found at the close of the chapters.

Many portions of the book are characterized by a decided freshness of treatment, and we have little doubt that the careful reader will find many little points which are satisfying, in that they tend to widen the somewhat restricted views he may have previously held, and these will be all the more apparent should his mind be of a mathematical turn. G. A. B.

OUR BOOK SHELF.

Magnetism and Electricity. By R. W. Stewart. (London: W. B. Clive and Co.)

THE book forms one of the University Correspondence College Tutorial Series, and is "primarily written for the use of candidates for the Matriculation, Intermediate Science, and Preliminary Scientific Examinations of the University of London." The author is evidently familiar with the difficulties which usually occur to students, and the best portions of the book are those in which efforts are made to elucidate some of the more general errors. The descriptions of apparatus and phenomena are, however, generally rather short and meagre, while the diagrams are frequently inadequate for a work of this sort. Little is written to help the beginner to perform experiments for himself; in fact, descriptions of many important instruments are omitted—for example, the Wheatstone

Bridge—and to students having no access to a laboratory little satisfaction will be given when told : "The details of the construction and practical use of the different forms of Wheatstone's Bridge used in the measurement of resistance are best learnt in the laboratory, and for this reason we shall not give any further description of the arrangement."

In many instances the student is driven through a mass of theory before he has a fair idea of the general phenomena; thus in the introductory chapter on "Current Electricity," after a six-line description of a simple cell and current, over two pages are occupied in proving that the effects produced could be explained by the dissociation and procession of the hydrogen and oxygen atoms. The work is generally remarkably free from errors and misprints, but one occurs in the explanation just mentioned. The attraction of zinc for oxygen is said to be much greater than that of the copper, while later the zinc is also considered "to *repel* hydrogen *less*." Here, and in many other instances, the words to be emphasised are printed in italics. Another mistake will be found on pp. 168 and 169, where in comparing, by the method of oscillations, the field due to a magnet with that of the earth, the author starts with the equation $\frac{I+H}{I}=\frac{n_1^2}{n^2}$ instead of $\frac{I+H}{H}=\frac{n_1^2}{n^2}$, and reasoning correctly from this false hypothesis, he deduces false results, while the answer to Ex. 8 on this part of the subject appears incorrect. Fig. 13, p. 201, in illustration of Oerstedt's experiment, is not correctly drawn.

The arrangement of "calculations" and examples at the end of each chapter must prove extremely useful to students possessing beforehand an elementary knowledge of the general phenomena, and to such, rather than to the very beginner, the book may be commended. H. S. J.

Manners and Monuments of Prehistoric Peoples. By the Marquis de Nadaillac. Translated by Nancy Bell (N. D'Anvers). (New York and London: G. P. Putnam's Sons, 1892.)

A BOOK summing up in a popular style all that is now known with regard to prehistoric man would probably be welcomed by a tolerably large class of readers. The present work does not quite supply the kind of summary that is wanted. The author does not distinguish with sufficient clearness between the various periods with which he deals; he indulges too freely in talk of a vaguely moralising tendency; and some of his statements do not accord with the conclusions of the best authorities. Speaking of the Round Towers of Ireland, for instance, he says, "According to the point of view of different archæologists, they have been called temples of the sun, hermitages, phallic monuments, or signal towers." The reader is thus left to suppose that the question is still open, whereas all competent students of the subject accept the theory of the late Mr. Petrie, a theory which the Marquis de Nadaillac does not even mention. However, the author has presented a large number of interesting facts in the course of his exposition, and there are occasional passages in which he brings out very well the attractive elements of some of the more fascinating departments of archæology.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Two Statements.

IN a letter addressed to the *Daily Chronicle*, dated January 25, 1893, Prof. Karl Pearson makes two statements respecting my opinions and grounds of action:

"As in society at large, so in academic matters, his mode of insuring progress is unlimited individual competition,"

and again:

"he is an individualist in all matters."

Seeing that in an essay "On Administrative Nihilism," published twenty-two years ago; and in another on "Government: Anarchy or Regimentation," published in 1890, I have done my best to combat the doctrine Prof. Pearson attributes to me, I shall be glad to know what justification he has to offer for so grave a misrepresentation. The purpose of it is obvious.

T. H. HUXLEY.

Hodeslea, Eastbourne, January 29.

A Meteor.

THE following is taken from the Pretoria *Weekly Press* for January 7: "A few evenings ago a meteor of unusual size and brilliancy was observed at Bloemfontein shooting right across the eastern sky. It looked like a rocket of a greenish colour, and burst in a shower of sparks in the south-east. The spectacle was much admired by those who were fortunate enough to witness it."

This meteor, as seen in South Africa, appears to have had many points in common with a similar one seen in England about the same time, and reported by several observers in the daily Press. W. L. DISTANT.

Purley, Surrey, January 31.

"Hare-lip" in Earthworms.

ATTENTION has recently been drawn by Prof. Andrews (*American Naturalist*, September, 1892) and myself (*Science Gossip*, 1892) to some abnormal conditions of life among the terrestrial annelids. I have now to place on record a totally new appearance, which is, I think, very aptly expressed by the term "hare-lip." The worm which I have had under examination presented the peculiarity figured below, and when alive and in motion suggested to my mind most forcibly the appearance which we associate with the name I have adopted.

The specimen in question belongs to the genus Allolobophora, in which genus, so far as my experience goes, almost all the abnormalities are found. The genus Lumbricus, it should be observed, is very seldom, if ever, known to present any of these peculiarities. Hitherto the Long worm (*A. longa*, Ude)

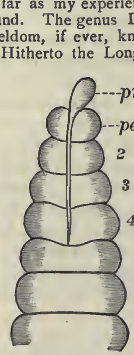


Diagram of the anterior portion of green-worm (*Allolobophora chlorotica*. Savigny), showing abnormal appearance of lip (*pr*), peristomium (*per*), and three succeeding segments, seen from above, and enlarged.

has been most prolific of bifurcated heads and tails. Now we find the Green worm (*A. chlorotica*, Savigny) yielding new features for study. The peculiarities which have presented themselves in former times have usually taken the form of a second head or a supernumerary tail. In this instance there is no off-growth, however, but merely a malformation of the anterior segments. One might have supposed that the peculiarity was due to accidental causes. It would have been easy to suppose that the head had been split, and then the wound had healed, leaving a seam down the middle. I observed, however, that each of the three specimens of the Green worm which I received from Cork (Ireland) showed some abnormal feature, and there were other peculiarities in this particular specimen which indicated that we had to deal with a congenital rather than an accidental condition of things.

As this is the first occasion on which such a peculiarity has been recorded or figured, I prefer to leave all speculation as to the cause out of the question. We need a good deal more research before we can deal satisfactorily with the biological problems involved in such appearances. As a help towards this, I bring together here a list of all those works which have come under my own and Prof. Andrews's notice, in which abnormalities in annelids are recorded:—

1. Andrews: "Proc. U.S. Nat. Mus.," vol. xiv., p. 283, 1891.
2. Andrews: "Amer. Nat.," vol. xxvi., p. 725, 1892.
3. Bell: "Ann. Mag. Nat. Hist.," vol. xvi., p. 475, 1885.
4. Bell: "Proc. Zool. Soc., Lond.," 1887, p. 3.
5. Bonnet: "Œuvres d'Hist. Nat. et de Phil.," vol. i., p. 167 seq. 1779.
6. Breese: West Kent Nat. Hist. Soc., 1871.
7. Broome: "Trans. Nat. Hist. Soc." Glasgow, 1888, p. 203.
8. Bülow: "Archiv. f. Naturg," vol. xlix., 1883.
9. Brunette: "Travaux de la Sta. Zool. de Cette," p. 8, Nancy, 1888.
10. Claparède: "Les Chaet. du Golfe de Naples," p. 436, 1868.
11. Fitch: "Eighth Report on Insects of State of New York," appendix, p. 204 seq. Albany, 1865.
12. Foster: Hull Scientific Club, February, 1891. Reported in weekly sup. *Leeds Mercury*.
13. Friend: "Science Go sip," 1892, pp. 108, 161.
14. Grube: "Archiv. f. Naturg.," vol. x., p. 200, 1844.
15. Horst: "Tydsch. ned. Dierk. Veren," 2nd ser., D.I., Af. i., p. xxxii, 1882.
16. Laugerhaus: "Nov. Act., K.L.C.D. Acad.," vol. xiii., p. 102, 1879.
17. Marsh: "Amer. Nat.," vol. xxiv., p. 373, 1890.
18. Macintosh: "*Challenger* Reports," vol. xii., 1885.
19. Robertson: "Quart. J. Mic. Soc.," vol. xv., p. 157, 1867.
20. Zeppelin: "Zeit. f. Wiss. Zool.," vol. xxxix., p. 615 seq. 1883.
21. Catalogue Terat. Spec. in Mus. Roy. Coll. Surgeons, London, 1872.

HILDERIC FRIEND.

The Zero Point of Dr. Joule's Thermometer.

IN the course of a discussion on "Exact Thermometry" I described (NATURE, vol. xli. p. 488) the results obtained by heating thermometers for a considerable time to 280° and 356°; and pointed out by means of a diagram that at 356°, after about ten hours, the rise of the zero point became—at any rate approximately—a rectilinear function of the logarithm of the time; though at 280°, even after more than 300 hours' heating, the rise appeared to be rather more rapid than would correspond to such a simple relation.

Dr. Joule observed the rise of the zero point of a thermometer at the ordinary temperature during a course of no less than thirty-eight years ("Scientific Papers," vol. i. p. 558), and it occurred to me that it would be of interest to ascertain the relation to the logarithm of the time in this case also.

The following table contains the dates of Dr. Joule's observations; the total number of months from the date when the first reading was taken; the corresponding logarithms; the total rise of the zero point in scale divisions (13 divisions to 1° F.); the total rise calculated from the formula $R = 6{\cdot}5 \log. t - 4{\cdot}12$, where t is the time in months; and lastly the differences between the observed and calculated zero points.

Date.	Time in Months.	Log. t.	Total rise of zero point in scale divisions. Observed.	Calculated.	Δ
April 1844	0	—	0	—	—
Feb. 1846	22	1·342	5·5	4·6	−0·9
Jan. 1848	45	1·653	6·6	6·6	0
April 1848	48	1·681	6·9	6·8	−0·1
Feb. 1853	106	2·025	8·8	9·0	+0·2
April 1856	144	2·158	9·5	9·9	+0·4
Dec. 1860	200	2·301	11·1	10·8	−0·3
March 1867	275	2·439	11·8	11·7	−0·1
Feb. 1870	310	2·491	12·1	12·1	0
Feb. 1873	346	2·539	12·5	12·4	−0·1
Jan. 1877	393	2·594	12·71	12·74	+0·03
Nov. 1879	427	2·630	12·92	12·98	+0·06
Dec. 1882	464	2·667	13·26	13·22	−0·04

The agreement between the observed and calculated values is certainly remarkable, and the + and − differences are evenly distributed.

Ten years have now elapsed since the last reading was taken, and if the thermometer is still in existence it would be of great interest to know what further rise has taken place in its zero point. According to the equation the reading should now be 13·86.

SYDNEY YOUNG

University College, Bristol, January 20.

THE APPROACHING SOLAR ECLIPSE, APRIL 15–16, 1893.

THE total solar eclipse of April 15–16, 1893, is not only one of the longest of the century, but is the last of the century from which we are likely to get any addition to our knowledge of Solar Physics. The longest duration of totality of this eclipse is 4 minutes 46 seconds, and as the path of the moon's shadow lies to a great extent on land, there is a considerable choice of possible stations with long durations of totality. Commencing in the Southern Pacific the line of totality passes in a north-easterly direction and enters Chili at Charañah in 29° southern latitude, crosses the South American continent, and issues at Para Cura, a village near Ceara, at the north-east corner of Brazil, in latitude 3° 40′ south. It crosses the Atlantic at its narrowest part and enters Africa at Point Palmerin, near Joal, almost midway between Bathurst and Dakar, and in latitude 14° north; the shadow finally leaving the earth in the interior of Northern Africa. The eclipse will be observed by several parties of astronomers in Chili, Brazil, and Africa, there being almost absolute certainty of fine weather in Chili and Africa, and a reasonable probability in Brazil.

The English arrangements to observe the eclipse have been made by a joint committee of the Royal Society, the Royal Astronomical Society, and the Solar Physics Committee of the Science and Art Department, South Kensington; Dr. A. A. Common, LL.D., F.R.S., undertaking the duties of Secretary. Two expeditions will be sent from England, one to Africa and the other to Brazil, the expenses being defrayed by a grant of £600 from the Royal Society.

The African expedition will be in charge of Prof. T. E. Thorpe, and will consist of Prof. Thorpe, Mr. A. Fowler, Mr. Gray, and Sergeant J. Kearney, R.E. The Brazilian expedition will be in charge of Mr. A. Taylor, who will have with him Mr. W. Shackleton.

Prof. Thorpe and his party will leave Liverpool by the British and African mail steamer on March 18th, arriving at Bathurst on April 2nd. They will be met at Bathurst by a gunboat kindly placed at the disposal of the expedition by the Admiralty, and will be conveyed at once to Fundium, a station on the Salum River, about sixty miles from Bathurst; this being the station selected by the Committee from the three which were offered by the French Government. The gunboat will remain with the expedition, and the officers and crew will assist in the preparations for and in the actual observations of the eclipse. After the eclipse the party will be taken to Bathurst on the gunboat, and will return to England by a British and African mail steamer, if one is available. From the time-tables of the steamers now published it appears, however, that there will not be any mail steamer available until the end of April, and in this case a cruiser will meet the party at Bathurst and bring them to the Canary Islands or to Gibraltar, from either of which places they will be able to return by mail steamer, arriving in England early in May.

The members of the expedition to Brazil will leave Southampton by the Royal Mail steamer on February 23 for Pernambuco, arriving at the latter place on March 12. They will take passage by the local mail steamers to Ceara, at which place they will arrive about March 20.

The Brazilian Government are willing to place a war vessel at the disposal of the foreign expeditions to observe the eclipse, and it is hoped the English observers will be able to avail themselves of the privilege thus gracefully offered. The station selected is at Para Cura, on the coast about forty miles west of Ceara, and the party will rely upon obtaining any necessary help from the Brazilian authorities and from local assistants. The observers will return from Pernambuco by the Royal Mail steamer due to leave there on April 22, and expect to be in England on May 5.

The objects of the expeditions are—

(1) To obtain visual photometric measures of the light of the corona.

(2) To obtain photographs of the corona with the four-inch lenses of a little over sixty inches focus belonging to Captain Abney, which were successfully used in Egypt (1882), Caroline Island (1883), Granada (1886), and Salut Isles (1889), in order to continue the series.

(3) To obtain enlarged photographs of the corona with small photographic action, so as to show details of the structure of the brightest parts, *i.e.* those nearest the sun.

(4) To measure the photographic intensity of the light of the corona, by direct comparison with standard intensity scales placed on the margins of the plates used for the negatives to be obtained under sections 2 and 3.

(5) To obtain photographs of the spectrum of the corona. These spectra will be obtained on three different plans:—

(*a*) With integrating spectroscopes, where no collimator is used and the prism or prisms are placed directly in front of the object glass of the photographic camera.

(*b*) With ordinary slit spectroscopes, the slit being arranged as a radius of the sun.

(*c*) With ordinary slit spectroscopes, the slit being arranged as a tangent to the sun's limb.

The first of these objects will be attempted only at the African station; Prof. Thorpe and his assistant, Mr. Gray, making the observations. Their equipment will consist of a six-inch Simms equatorial of seventy-eight inches focus (lent from Greenwich) fitted with special photometric apparatus lent by Captain Abney. The observations will be made on essentially the same plan as that pursued by Prof. Thorpe at Hog Island, near Granada, in 1886, separate portions of the corona being compared with a standard glow lamp by means of a Bunsen photometer. An integrating box for measuring the total coronal light with as little light from the sky as possible, and an ordinary Bunsen's bar photometer will also be used, these being entrusted to officers of the gunboat.

As regards objects 2, 3, and 4, duplicate apparatus has been arranged for use at the two stations.

A photoheliograph mounting from Greenwich has been lent for Brazil, and an exactly similar instrument from South Kensington for Africa. On each of these mountings a specially designed new double tube will be fixed. An Abney lens will be mounted in one compartment of each of these tubes, and this, with a focal length of sixty inches, will give pictures on the scale of rather more than half an inch to the moon's diameter. In the other compartment a four-inch Dallmeyer photoheliograph lens will be mounted in combination with a specially-constructed two-and-a-half-inch Dallmeyer negative lens of eight inches negative focus; this arrangement giving, with a total length of sixty-eight inches, pictures on the scale of over one-and-a-half inches to the moon's diameter. This latter arrangement is essentially the same as that of Dallmeyer's new telephotographic lens. It will be so arranged that the ratio between the photographic effect of the Abney lens and the new combination will be as 10 : 1.

Special plate holders have been made to fit the double tubes, each of these plate holders carrying two plates, which will be exposed simultaneously to the images formed by the Abney lens and the enlarging combination. The six separate exposures, giving twelve photographs, will be so arranged that the longest exposed pictures with the enlarging combination will have received the same photographic action as the shortest exposed pictures with the Abney lens. The whole of the pictures will thus form a continuous series, all the short exposures in the series having a direct enlargement of three diameters.

In Brazil Mr. Taylor will take charge of this double instrument, and in Africa the similar instrument will be entrusted to Sergeant Kearney. On the night before the eclipse intensity scales for object 4 will be impressed by the use of standard lights and specially-constructed scales kindly supplied by Captain Abney on all the plates to be exposed to the corona. The plates will be developed at the stations as soon as convenient after the eclipse, experience on previous occasions, both by English and American observers, having shown that it is impossible to repack undeveloped plates after exposure in the tropics, and bring them home without serious deterioration.

Similar spectroscopic work is to be carried out at the two stations. For the integrating spectroscope in Africa Mr. Fowler will use a six-inch objective prism with a six-inch photographic lens of about nine-feet focus, mounted on an equatorial stand, belonging to Prof. J. Norman Lockyer, and kindly lent for the expedition. At the Brazilian station Mr. Shackleton will use two three-inch prisms in front of a three-inch photographic lens of about two-feet focus; the spectroscope, which belongs to South Kensington, being arranged horizontally and used with a ten-inch heliostat, also lent by the Science and Art Department. Very short exposures will be given at each station at the commencement and end of totality, so as to obtain, if possible, the very numerous bright lines which have been observed in the chromosphere; and exposures of from 5 to 45 seconds will be given during totality.

In Africa the radial and tangential slit spectroscopes will be mounted together on the Corbett equatorial stand lent from Greenwich, the spectroscopes used belonging to the Royal Society. Mr. Fowler and Sergeant Kearney will erect and adjust these instruments, but the actual exposure, which will extend through the whole of totality, will be made by an officer of the gunboat who will be placed in charge of the instrument. In Brazil the radial and tangential slit spectroscopes will be mounted horizontally and used with a second ten-inch heliostat lent by the Science and Art Department. The erection and adjustment will be made by the observers, but the actual exposure during totality will be entrusted to a local assistant. Orthochromatic plates will be used for all the spectroscopic work, the spectra obtained extending from above D into the ultra-violet.

Briefly summarised, the English programme is as follows:—

In Africa:—Prof. T. E. Thorpe, assisted by Mr. Gray and local assistance—Photometric measures of the visual intensity of the corona with the equatorial photometer, the integrating photometer, and the bar photometer; Mr. Fowler—The six-inch integrating spectroscope; Sergeant Kearney—the Abney and Dallmeyer coronographs; local assistance—the radial and tangential slit spectroscopes.

In Brazil:—Mr. Taylor, the Abney and Dallmeyer coronographs; Mr. Shackleton, the three-inch two-prism integrating spectroscope; local assistance, the radial and tangential slit spectroscopes.

It is not yet decided whether one of the 20-inch mirrors of 45-inches focus specially constructed to photograph the faint extensions of the corona during the eclipse of 1889 (December 21–22) will be taken to Africa. If so it will be entrusted to a local assistant. It was originally intended to use one of these in Africa, and it was hoped that one would be used by the Harvard College

Observatory party, which is to occupy a station in Chili, but Prof. W. H. Pickering writes that difficulties of transport will prevent him from taking the 20-inch mirror he has at Arequipa to the Harvard station; and owing to this and to the already large programme of the English party in Africa there is some doubt whether they will take one of the mirrors. April being the middle of the rainy season in Brazil, it is not deemed advisable to send one of the mirrors to that station.

The duration of totality at Para Cura is four minutes forty-four seconds, the altitude of the sun being between 70° and 80°. At Fundium the totality lasts four minutes eight seconds, the altitude of the sun being about 54°.

The Joint Eclipse Committee having arranged the expeditions and the general scheme of work, final details as to the actual operations have been left to a sub-committee consisting of the Astronomer Royal, Captain Abney, Mr. H. H. Turner, Prof. Thorpe, Mr. A. Taylor, and the secretary, Dr. Common. Prof. Lockyer, previous to leaving England for Egypt, determined the exposures to be given by Messrs. Fowler and Shackleton with the integrating spectroscopes. These, with the final instructions to observers drafted by the sub-committee, will be published in due course.

At present very few details are available as to the actual work to be undertaken by foreign observers. The Harvard College Observatory expedition to Chili has already been mentioned. Prof. Schaeberle, of the Lick Observatory, has already started for Chili, and will use a six-and-a-half-inch equatorial, a five-inch horizontal photoheliograph of forty-feet focus, and a Dallmeyer portrait lens. He will be assisted by Mr. Gale, an amateur, from Paddington, N.S.W. A Chilian party will also observe the eclipse in Chili.

At Para Cura there will probably be two or three American parties, one being announced as probably under Prof. H. S. Pritchett, from Washington University, St. Louis, and another will probably be brought to that station by Prof. David P. Todd. A Brazilian party will also observe. The Bureau des Longitudes, Paris, are sending a complete expedition to Joal, in Africa, under MM. Deslandres and Bigourdan, the latter observer having already started for his station. The work undertaken will be to obtain photographs of the corona and of its spectrum. M. de la Baume Pluvinel will also go to Joal to photograph the corona. At present we have not heard of any Italian expedition, but it is hoped that Prof. Tacchini will be able to arrange to observe the eclipse.

A. TAYLOR.

MEASURE OF THE IMAGINATION.[1]

THE first perceptible sensation is seldom due to a solitary stimulus. Internal causes of stimulation are in continual activity, whose effects are usually too faint to be perceived by themselves, but they may combine with minute external stimuli, and so produce a sensation which neither of them could have done singly. I desire now to draw attention to another concurring cause which has hitherto been unduly overlooked, or only partially allowed for under the titles of expectation and attention. I mean the Imagination, believing that it should be frankly recognised as a frequent factor in the production of a just perceptible sensation. Let us reflect for a moment on the frequency with which the imagination produces effects that actually overpass the threshold of consciousness, and give rise to what is indistinguishable from, and mistaken for a real sensation. Every one has observed instances of it in his own person and in those of others. Illustrations are almost needless; I may, however, mention one as a reminder; it was current in my boyhood, and the incident probably took place not many yards from where I now stand. Sir Humphrey Davy had recently discovered the metal potassium, and showed specimens of it to the greedy gaze of a philosophical friend as it lay immersed in a dish of alcohol to shield it from the air, explaining its chemical claim to be considered a metal. All the known metals at that time were of such high specific gravity that weight was commonly considered to be a peculiar characteristic of metals; potassium, however, is lighter than water. The philosopher not being aware of this, but convinced as to its metallic nature by the reasoning of Sir Humphrey, fished a piece out of the alcohol, and, weighing it a while between his finger and thumb, said seriously, as in further confirmation, "How heavy it is!"

In childhood the imagination is peculiarly vivid and notoriously leads to mistakes, but the discipline of after life is steadily directed to checking its vagaries and to establishing a clear distinction between fancy and fact. Nevertheless, the force of the imagination may endure with extraordinary power and be cherished by persons of poetic temperament, on which point the experiences of our two latest Poet-Laureats, Wordsworth and Tennyson, is extremely instructive. Wordsworth's famous "Ode to Immortality" contains three lines which long puzzled his readers. They occur after his grand description of the glorious imagery of childhood, and the "perpetual benediction" of its memories, when he suddenly breaks off into—

> "Not for these I raise
> The song of thanks and praise,
> But for those obstinate questionings
> Of sense and outward things,
> Fallings, from us, vanishings," &c.

Why, it was asked, should any sane person be "obstinately" disposed to question the testimony of his senses, and be peculiarly thankful that he had the power to do so? What was meant by the "fallings off and vanishings," for which he raises his "song of thanks and praise"? The explanation is now to be found in a note by Wordsworth himself, prefixed to the ode in Knight's edition. Wordsworth there writes—"I was often unable to think of external things as having external existence, and I communed with all I saw as something not apart from, but inherent in, my own immaterial nature. Many times while going to school have I grasped at a wall or tree to recal myself from this abyss of idealism to the reality. At that time I was afraid of such processes. In later times I have deplored, as we all have reason to do, a subjugation of an opposite character, and have rejoiced over the remembrances, as is expressed in the lines 'Obstinate questionings,' &c." He then gives those I have just quoted.

It is a remarkable coincidence that a closely similar idea is found in the verses of the successor of Wordsworth, namely, the great poet whose recent loss is mourned by all English-speaking nations, and that a closely similar explanation exists with respect to them. For in Lord Tennyson's "Holy Grail" the aged Sir Percivale, then a monk, recounts to a brother monk the following words of King Arthur:—

> "Let visions of the night or of the day
> Come, as they will; and many a time they come
> Until this earth he walks on seems not earth,
> This light that strikes his eyeball is not light,
> The air that smites his forehead is not air,
> But vision," &c.

Sir Percivale concludes just as Wordsworth's admirers formerly had done: "I knew not all he meant."

Now, in the *Nineteenth Century* of the present month

[1] Extract from a lecture on "The Just-Perceptible Difference," delivered before the Royal Institution, on Friday, January 27, by Francis Galton, F.R.S. We hope to give next week an extract on "Optical Continuity."

[1] Knight's edition of Wordsworth, vol. iv. p. 47.

Mr. Knowles, in his article entitled "Aspects of Tennyson," mentions a conversational incident curiously parallel to Wordsworth's own remarks about himself:—"He [Tennyson] said to me one day, 'Sometimes as I sit alone in this great room I get carried away, out of sense and body, and rapt into mere existence, till the accidental touch or movement of one of my own fingers is like a great shock and blow, and brings the body back with a terrible start."

Considering how often the imagination is sufficiently intense to stimulate a real sensation, a vastly greater number of cases must exist in which it excites the physiological centres in too feeble a degree for their response to reach to the level of consciousness. So that if the imagination has been anyhow set into motion, it shall as a rule originate what may be termed *incomplete* sensations, and whenever one of these concurs with a real sensation of the same kind, it would swell its volume.

This supposition admits of being submitted to experiment by comparing the amount of stimulus required to produce a just perceptible sensation, under the two conditions of the imagination being either excited or passive.

Several conditions have to be observed in designing suitable experiments. The imagined sensation and the real sensation must be of the same quality; an expected scream and an actual groan could not reinforce one another. Again, the place where the image is localised in the theatre of the imagination must be the same as it is in the real sensation. This condition requires to be more carefully attended to in respect to the visual imagination than to that of the other senses, because the theatre of the visual imagination is described by most persons, though not by all, as internal, whereas the theatre of actual vision is external. The important part played by points of reference in visual illusions is to be explained by the aid they afford in compelling the imaginary figures to externalise themselves, superimposing them on fragments of a reality. The visualisation and the actual vision fuse together in some parts, and supplement each other elsewhere.

The theatre of audition is by no means so purely external as that of sight. Certain persuasive tones of voice sink deeply, as it were, into the mind, and even simulate our own original sentiments. The power of localising external sounds, which is almost absent in those who are deaf with one ear, is very imperfect generally, otherwise the illusions of the ventriloquist would be impossible. There was an account in the newspapers a few weeks ago of an Austrian lady of rank who purchased a parrot at a high price, as being able to repeat the Paternoster in seven different languages. She took the bird home, but it was mute. At last it was discovered that the apparent performances of the parrot had been due to the ventriloquism of the dealer. An analogous trick upon the sight could not be performed by a conjuror. Thus he could never make his audience believe that the floor of the room was the ceiling.

As regards the other senses the theatre of the imagination coincides fairly well with that of the sensations. It is so with taste and smell, also with touch, in so far that an imagined impression or pain is always located in some particular part of the body, then if it be localised in the same place as a real pain, it must coalesce with it.

Finally, it is of high importance to success in experiments on Imagination that the object and its associated imagery should be so habitually connected that a critical attitude of the mind shall not easily separate them. Suppose an apparatus arranged to associate the waxing and waning of a light with the rising and falling of a sound, holding means in reserve for privately modifying the illumination at the will of the experimenter, in order that the waxing and waning may be lessened, abolished, or even reversed. It is quite possible that a person who had no idea of the purport of the experiment might be deceived, and be led by his imagination to declare that the light still waxed and waned in unison with the sound after its ups and downs had been reduced to zero. But if the subject of the experiment suspected its object he would be thrown into a critical mood; his mind would stiffen itself, as it were, and he will be difficult to deceive.

Having made these preliminary remarks, I will mention one only of some experiments I have made and am making from time to time, to measure the force of my own imagination. It happens that although most persons train themselves from childhood upwards to distinguish imagination from fact, there is at least one instance in which we do the exact reverse, namely, in respect to the auditory presentation of the words that are perused by the eye. It would be otherwise impossible to realise the sonorous flow of the passages, whether in prose or poetry, that are read only with the eyes. We all of us value and cultivate this form of auditory imagination, and it commonly grows into a well-developed faculty. I infer that when we are listening to the words of a reader while our eyes are simultaneously perusing a copy of the book from which he is reading, that the effects of the auditory imagination concur with the actual sound, and produce a stronger impression than the latter alone would be able to make.

I have very frequently experimented on myself with success, with the view of analysing this concurrent impression into its constituents, being aided thereto by two helpful conditions, the one is a degree of deafness which prevents me when sitting on a seat in the middle rows from following memoirs that are read in tones suitable to the audience at large; and the other is the accident of belonging to societies in which unrevised copies of the memoirs, that are about to be read, and usually in monotones, are obtainable, in order to be perused simultaneously by the eye. Now it sometimes happens that portions of these papers, however valuable they may be in themselves, do not interest me, in which case it has been a never-flagging source of diversion to compare my capabilities of following the reader when I am using my eyes, and when I am not. The result depends somewhat on the quality of the voice; if it is a familiar tone I can imagine what is coming much more accurately than otherwise. It depends much on the phraseology, familiar words being vividly re-presented. Something also depends on the mood at the time, for imagination is powerfully affected by all forms of emotion. The result is that I frequently find myself in a position in which I hear every word distinctly so long as they accord with those I am perusing, but whenever a word is changed, although the change is perceived, the new word is not recognised. Then, should I raise my eyes from the copy, nothing whatever of the reading can be understood, the overtones by which words are distinguished being too faint to be heard. As a rule, I estimate that I have to approach the reader by about a quarter of the previous distance, before I can distinguish his words by the ear alone. Accepting this rough estimate for the purposes of present calculation, it follows that the potency of my hearing alone is to that of my hearing *plus* imagination, as the loudness of the same overtones heard at 3 and at 4 units of distance respectively; that is as about 3^2 to 4^2, or as 9 to 16. Consequently the potency of my auditory imagination is to that of a just perceptible sound as 16–9, or as 7 units, to 16. So the effect of the imagination in this case reaches nearly half-way to the level of consciousness. If it were a little more than twice as strong it would be able by itself to produce an effect indistinguishable from a real sound.

Two copies of the same newspaper afford easily accessible materials for making this experiment, a few words having been altered here and there in the copy to be read from.

I will conclude this portion of my remarks by suggesting that some of my audience should repeat these experiments on themselves. If they do so, I should be grateful if they would communicate to me their results.

PROTOCERAS, THE NEW ARTIODACTYLE.

LAST year the American Museum of Natural History established a department of mammalian palæontology for the purpose of securing and exhibiting collections from all the tertiary horizons of the west. Dr. J. L. Wortman, well known by his discoveries while associated with Prof. Cope, was put at the head of the field work, and under his direction explorations have already been made in the Laramie or Upper Cretaceous, and in three of the great divisions of the tertiary, namely, the Wasatch, the Puerco, and the Lower Miocene or White River.

The discovery of the first example of *Palæonictis* found in America was mentioned in NATURE last year. From the Puerco are brought remains of about 400 individuals, adding many new facts to the discoveries of Prof. Cope. From the Laramie are 400 of the small isolated teeth of the kind recently described by Prof. Marsh. These are found by the writer to have a distinctly tertiary rather than mesozoic character, and while intermediate between the mesozoic and Puerco species, they decidedly resemble the latter. *Meniscoëssus*, for example, about which there has been so much discussion, proves to be a plagiaulacid,

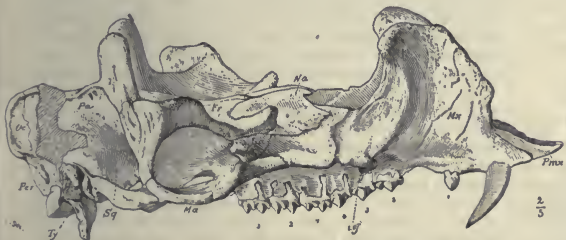


FIG. 1.—Side view of skull.

and also an ancestor of *Polymastodon*, which is thus shown to be a huge *Plagiaulax*, in which the fourth cutting premolar is reduced.

By far the most perfect specimens have, however, been brought from the Lower Miocene; and here it appears that practically a new horizon has been developed, for the collection is full of fresh forms. Many of these are new species intermediate between the true White River or *Titanotherium* fauna, and the Middle Miocene, but others are new genera, and represent distinct unrelated forms.

In this Lower Miocene collection are included portions of six skulls and the fore and hind feet of an Artiodactyle, of about the size of a sheep. The most complete skull is here figured exactly as found, and is seen at once to depart from all known Artiodactyles in many important characters. There are no less than four protuberances upon each side of the skull. Hindmost are two processes upon the parietals, which are placed upon the superciliary ridges as they diverge from the sagittal crest. These processes are close together and oval in section, reminding us of the posterior pair of horns in *Uintatherium* rather than of the conical or rounded horns found in the giraffes and some other Artiodactyles. Their position upon the parietal bones is also peculiar. The superciliary ridges extend outwards into two widely projecting plates of bone, which curve upwards above the orbits; these plates are upon the frontals, and the frontals also bear a pair of small conical processes just behind their junction with the nasals. But even more exceptional than these parietal and frontal processes are the great vertical plates rising from the maxillaries, slightly recurved, and reaching the full height of the parietal protuberances. Seen from above, these plates are found to be not in contact, but to enclose a long deep cleft, representing the anterior narial opening. This is bridged over posteriorly by the nasals, which, as shown in the second figure, are extremely abbreviated. Correlated with the development of these processes are a number of strong ridges, which form supporting buttresses for the horns. These extend, as above described, from the sagittal crest outwards, also from the anterior margin of the orbit forwards. This lateral maxillary ridge, as it may be called, terminates in a process just above the infraorbital foramen; and this process, although small, seems to illustrate the remarkable tendency of this little skull to develop osseous projections at every avail-

FIG. 2.—Top view of skull.

able point. The character of these projections is different from that found elsewhere among the Artiodactyla; they are not horn-cores, neither are they similar to the processes upon the parietals of the giraffe. The development of these multiple bony protuberances suggests the skulls of Sivatherium, Tetraceros, and other eastern ruminants; but the proportions of the skull are wholly different. The olfactory chamber, which is usually so expanded in the Artiodactyla, is here extremely reduced; the nasals barely reach beyond the middle line of the skull.

Up to this point the study of the skull appeared to present an entirely new form, but later the other skulls were removed from the matrix, and among them one was found with small canine teeth, entirely lacking all the processes upon the frontals, and giving indications that those upon the maxillaries were either absent or comparatively small. The parietals were unfortunately missing, but the idea at once suggested itself tha this might be a female skull. Two years ago Prof

Marsh described a small Artiodactyle with a pair of small conical horn-cores upon the parietal bones, which he named *Protoceras celer*, expressing the opinion that it represented a new family. Upon the supposition that this type might also be a female of the same species to which the heavily-horned type belonged, the second skull was taken to the Yale Museum, and carefully compared point by point. It proved to be identical in every respect. In this way the discovery was made that in *Protoceras*, as in so many other Artiodactyles, the male and female skulls differed widely from each other in their cranial armature. The male was as described above; the female exhibits merely a pair of very small conical processes upon the parietals, with perfectly smooth frontals, and maxillaries either of the normal type or with smaller protuberances than in the male.

The dentition at first suggests relationship to *Tragulus* and *Hyomoschus*. The premaxillaries are edentulous as in the ruminants; but in the lower jaw there are four small teeth shaped liked incisors, the outermost of which represents the canine. The upper canines are large,

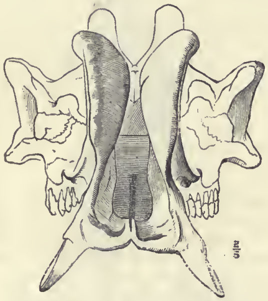


FIG. 3.—Front view of Skull.

pointed, and recurved. The molar teeth are of the short-crowned, or brachyodont type, with a distinctly crescentic pattern.

The structure of the feet also suggests the Tragulines, in the fact that the fore-foot has four well developed toes, while the hind-foot has two toes with the lateral pair very much reduced. As in the *Tragulidæ*, the fore-foot and probably the fore limb was very much shorter than the hind foot and limb. The hind foot, moreover, shows a tendency to co-ossification both in the metatarsals and in the union of the navicular and cuneiform with the cuboid. In many details, however, the feet present marked differences from the older and more recent Tragulines. The oldest of the Tragulines, moreover, is *Leptomeryx*, a contemporary of *Protoceras*, which has an entirely different skull and foot structure.

Taking all these facts together, we are led to support Prof. Marsh's conjecture, based upon the comparatively hornless female skull, that this Artiodactyle represents a new family, the *Protoceratidæ*. We know absolutely nothing either of the ancestors or successors of this type; and this is another illustration of the fact which is constantly being impressed upon us, that our fossil-bearing strata still contain a great number of forms which are at present wholly unknown and unsuspected.

HENRY F. OSBORN.

HENRY F. BLANFORD, F.R.S.

MR. H. F. BLANFORD, whose death was noticed in last week's NATURE, was born in Bouverie Street, Whitefriars, in the City of London, in 1834. He was one of the students who entered the Royal School of Mines at its commencement in 1851, and after distinguishing himself by taking the first Duke of Cornwall's Scholarship, he studied for a year at Freiberg in Saxony. In 1855 he and his brother, Mr. W. T. Blanford, received appointments on the Geological Survey of India, and they landed in Calcutta at the end of September in that year. Mr. H. F. Blanford remained on the Geological Survey till 1862, when he resigned, his health having suffered from the exposure incidental to geological surveying in India. His most important work whilst engaged on the Survey was the examination of the cretaceous beds of the neighbourhood of Trichinopoly, his classification of which, founded to a considerable extent on palæontological data, has been thoroughly confirmed by Dr. F. Stoliczka's well-known description of the fauna. Mr. Blanford had previously, during his first season's work in India, by separating the Talchir strata, with their remarkable boulder bed, from the true coal-bearing, or Damuda rocks, taken the first step in what for so long was one of the most difficult tasks set before the Indian Geological Survey—the stratigraphical arrangement of the complex of beds subsequently known as the Gondwána system.

On leaving the Geological Survey he was offered a post in the Bengal Educational Department, and from 1862 to 1874 he was one of the professors of the Presidency College, Calcutta. Soon after 1862 he began to take a keen interest in meteorological questions, and after being for some time a member of a meteorological committee nominated by the government, he was, in April 1867, appointed Meteorological Reporter to the Government of Bengal, and placed in charge of an office established with a twofold purpose, to give storm warnings for the protection of shipping and to collect and record systematic meteorological observations throughout the Bengal presidency. Within a short time one most important result was obtained; the meteorological conditions under which cyclones originated in the Bay of Bengal were definitely ascertained, and it became practicable to say when a storm was a probable event, and in what part of the Bay it might be expected, and when a cyclone was impossible, although high winds might prevail. Meantime the various observatories of the country were being brought into order, and the observations rendered systematic.

In 1874 the Government of India became convinced of the necessity for placing all the meteorological observatories in India in communication with a central office, and Mr. Blanford was finally transferred from the educational staff of Bengal and made chief of the new meteorological department, with the official designation of Meteorological Reporter to the Government of India. The new post involved much travelling to visit out-stations, in order to ensure the exact comparison of barometers and other instruments. The organisation of the new department, however, progressed rapidly, and in a few years a series of papers from Mr. Blanford's pen on rainfall, wind directions, and other meteorological phenomena gave evidence to all interested in the science that valuable additions to it were being made by the Indian observations. The peculiar geographical conditions of India render its meteorology unusually simple, and of great scientific and practical importance. An admirable illustration, both of the peculiarity of Indian meteorology and of the practical results yielded by accurate observations, is afforded by the fact that no sooner was the whole system in working order, than it was found practicable some time before the commencement of the monsoon season, and of the rainfall, upon which in many provinces plenty or scarcity of food depends, to prepare a forecast of the approaching season, and to warn the Government of a possible deficiency of rain in particular parts of the country. The forecasts prepared have been found remarkably accurate.

Mr. Blanford retired from the Indian Service in 1888,

and has since resided at Folkestone. Of late his health has gradually given way, and he died on January 23, at the age of fifty-eight. He was elected a Fellow of the Royal Society in 1880, and was an honorary member of several foreign meteorological societies. He was President of the Asiatic Society of Bengal in 1884–85.

That he was a man of considerable intellectual power is shown by the somewhat unusual range of scientific questions on which he has left works and papers. Besides his geological and meteorological reports, he wrote for the Indian Geological Survey descriptions of the *Nautilidæ* and *Belemnitidæ* of the South Indian cretaceous rocks, and he assisted the late Mr. J. W. Salter in describing the Palæontology of Niti. He was also author of several papers on recent mollusca; and amongst his works are two treatises, one on the "Physical Geography of India," largely used as a text-book in Indian schools, and the other "An Elementary Geography of India, Burma, and Ceylon," published as one of Macmillan's Geographical Series.

NOTES.

WE learn from Sydney that steady progress is being made with the Macleay Memorial Volume, and that it will probably be ready for issue about the end of March.

AN announcement comes from Chicago that Mr. Eadweard Muybridge, who, it will be remembered, visited this country some time since on behalf of the University of Pennsylvania, will give at intervals, from May to October, in the "Zoopraxographical Hall of the Exposition," a series of lectures on the science of animal locomotion, especially in its relation to design in art.

ON Thursday next, February 9, Prof. Patrick Geddes will begin, at the Royal Institution, a course of four lectures on the factors of organic evolution; and on Saturday week, February 18, Lord Rayleigh will begin a course of six lectures on sound and vibration.

A TRANSLATION of Prof. Weismann's new work on "The Germ-plasm," recently noticed in NATURE, will appear in the "Contemporary Science Series" in the course of a few weeks.

LAST week a deputation, representing the New Decimal Association, the Chambers of Commerce and Trades Unions, as well as various scientific institutions, waited upon Sir William Harcourt, Chancellor of the Exchequer, to urge the Government to adopt the decimal and metrical system of weights, measures, and coinage, or to appoint a committee of inquiry into the subject. Mr. S. Montagu, M.P., as president of the New Decimal Association, having introduced the deputation, said that forty years ago there was great apathy upon the subject, but since then there had been inquiries by Select Committees and Royal Commissions into the question of the decimal currency, and though the reports of those bodies were satisfactory, no action had followed. The system had been adopted in Germany, Austria-Hungary, and Scandinavia; and in England there was now a good popular demand, such as Mr. Goschen said six years ago he was waiting for. Men of science like Lord Kelvin, Sir Henry Roscoe, and Sir John Lubbock, and educationists like Sir Philip Magnus and Dr. Gladstone desired the reform in order to economise brain-power; representatives of commerce desired it to assist them in their competition with rival nations; and the working classes were awake to the fact that years of labour were wasted by their children being compelled to learn that which could be rendered unnecessary. Several members of the deputation, including Sir Philip Magnus, having spoken, Sir William Harcourt replied. He said that every one who reflected on the question must see the great advantages which attach to the decimal system. But the practical difficulties in the way of the proposed change seemed to him for the present to be insurmountable. A decimal system was introduced into Europe by the French Revolution. That was a time when the whole of society was cast into the melting pot, and they changed, not only their notation, not only their metrical system, but the names of the months and the days of the week. The change in Germany took place, not in quiet times, but as a result of the unification of Germany. He believed that even in the United States of America the change was made consequent upon the establishment of the Federal system. He did not think that the habits of the people could be altered in quiet times. This applied very much to the measures as well as to the coinage. Sir William was ready as an individual to play his part in forwarding the progress of the decimal system and the metrical system; but the Government could do nothing in the matter. The people would have to be prepared for so great a change.

IT is worth noting that instruction in the principles of the decimal and metric systems is daily given in public elementary schools, and that this labour—as Mr. J. H. Yoxall, secretary of the National Union of Teachers, has pointed out in a letter to the *Times*—is imposed upon the children without hope of practical good to the community. Mr. Yoxall contends that if an Act of Parliament were to fix a date of five or ten years hence at which the decimal system should come into legal operation, the work of the schools and the precaution of the mercantile classes would by that time sufficiently prepare the way.

A DESTRUCTIVE earthquake occurred on Tuesday morning at the town of Zante. Several houses were totally destroyed, many more were partially wrecked, and there is hardly a building in the town which has not sustained damage in one form or another. The roof of the prison collapsed during the earthquake, and the guards had to be doubled to prevent the escape of the prisoners. The hospital was also so seriously damaged that it was deemed expedient to remove the patients. The shocks, which were general, were renewed again and again, and the whole population was thrown into a state of panic.

DURING the past week the temperature over these islands has been fairly high, the daily maxima often exceeding 50°, notwithstanding a temporary fall, amounting from 12° to 14° in Scotland and the midland counties of England, on Friday, accompanied by much fog in the south and east of England, while the air has been decidedly humid, the readings of the dry and wet bulb thermometers frequently showing little or no difference. These conditions have been due to deep depressions arriving from the Atlantic and passing in close proximity to our western and northern coasts. In those parts gales have been of almost daily occurrence, and on Sunday they extended as far as the English Channel. Rain has been frequent, but generally the fall has not been heavy, and the sky has generally been overcast and dull, although on Saturday the weather over the south of England was unusually bright and fine. The *Weekly Weather Report* of January 28 shows that the temperature exceeded the mean in all districts, the greatest excess being 4° in Scotland. Bright sunshine also exceeded the mean in some parts of Scotland and in the eastern portion of England, but in other parts of these islands there was a deficiency.

A MAP showing lines of equal magnetic declination for January 1, 1893, in England and Wales, has been very carefully prepared by Mr. W. Ellis, and published as a supplement to

the *Colliery Guardian* of January 6, 1893. The explanatory text states that, as before, the work depends on the magnetic surveys of Profs. Rücker and Thorpe. Mr. Ellis gives a table showing the relation between the diurnal variation of magnetic declination and sun-spots, as determined from the magnetic observations made at the Royal Observatory, Greenwich. The general mean at epochs of minima of sun-spots is 7·4 minutes, and at epochs of maxima 11·4 minutes of arc, and other magnetic elements show a similar relation. The period between successive epochs of maxima or of minima of sun-spots is well known to be on the average about 11 years, and the author points out the curious fact that the interval between the minimum and maximum is on the average $4\frac{1}{2}$ years, whilst from maximum to minimum it is 7 years. The relation existing between sun-spot maxima and minima and the diurnal magnetic variation has led many meteorologists to seek for some similar connection with meteorological phenomena, but Mr. Ellis states that no such relation has yet been conclusively established.

THE report of the administration of the Meteorological Department of the Government of India in 1891–92 shows continued activity and efficiency in all departments of the work, and bears testimony to the interest taken both by the public and by the *employés*. The number of observatories maintained by the Government at the end of the year was 165. As regards the actinometric work, an unusual amount has been done, owing to the favourable state of the weather, and the results have been forwarded to the Solar Physics Committee in London. The rainfall data are published month by month, and a large number of unsatisfactory rain gauges has been replaced by new ones. A larger amount of work under the head of marine meteorology has been done than in any previous year; several clerks are continually employed in collecting data from ships entering the various ports, and these observations have been utilised in preparing daily weather charts of the whole Indian area for a portion of the year. The systems of storm and flood warnings have been continued as in previous years, and observations have been taken in certain forests, in order to throw light on the influence of forest growth in modifying the distribution and amount of rainfall; a report upon this subject will shortly be prepared. Among the other papers being prepared for publication we note one on the relation between sun-spots and weather as shown by meteorological observations taken on board ships in the Bay of Bengal during the years 1855 to 1878.

AT the meeting of the Royal Botanic Society of London on Saturday a plant of the Sisal hemp (*Agave rigida*) was shown from the Society's gardens. This plant is now extensively grown in the Bahamas and Central America for its fibre. The secretary said that until lately, with the exception of two or three fibre plants, as hemp and cotton, commerce depended upon wild plants for its supplies, but so great was the demand now for fibres for papermaking and other uses that it had been found necessary to grow them specially.

THE Slöjd Association of Great Britain met on Saturday to receive the annual report, to elect officers, and to appoint an examining body. It was agreed that "Sloyd" should be substituted for "Slöjd" in the name of the Association. The system of handiwork which the society is seeking to introduce into schools has already been pretty extensively adopted in this country, especially in the north of England. Mr. Harris stated at the meeting that it was being received with approval in many different parts of the world. He had received communications from Napier, New Zealand, and Lahore, India, as to its adoption in these places.

AN American writer who was present at the Galileo Festival in Padua gives a very interesting account of it in the New York *Nation*. He refers to the speeches delivered in Italian by Sir Joseph Fayrer and Prof. George Darwin, to which we have already alluded. "They were," he says, "much appreciated by the audience: 'Parla bene!' 'Pronunzia bene!' one heard murmured in tones not devoid of surprise." The greatest orator of the occasion, according to this writer, was Prof. Schmurlo of Dorpat, in Russia. "The type of the lonely and ungainly scholar in appearance, he nevertheless spoke a few phrases so ultra-Italian in the ingenious gracefulness of their turn, that the audience went fairly wild with delight."

THE latest instalment of the Transactions of the Institution of Engineers and Shipbuilders in Scotland contains an interesting paper, by Mr. E. G. Carey, on the bridges of the Manchester Ship Canal. The paper is fully illustrated. The author notes that practically the whole of the bridge-work for this canal has been constructed in Glasgow from Scotch steel.

THE Smithsonian Institution has issued as one of its bulletins a full and very useful bibliography of the published writings of George Newbold Lawrence, the well-known ornithologist. The work has been done by Mr. L. S. Foster, who gives also a short sketch of Mr. Lawrence's career. Mr. Lawrence's collection of bird-skins is of great scientific value. It includes about 8000 specimens, and contains some three hundred types of new species of birds. The collection was deposited in the American Museum of Natural History, New York City, in May 1887. Mr. Foster says that the beneficial influence of the labours of Mr. Lawrence, with pen and pencil, on the progress of American ornithology, has been great and undisputed. It is particularly among the avifauna of the West Indies, Mexico, Central and South America, that his most strenuous efforts have been exerted.

IF we may trust a statement made on the authority of the Tokyo News Agency, it is not surprising that Japan is unwilling to be deprived of the privilege of fishing on the Korean coast. The number of Japanese boats engaged in the fishery is said to be no less than upwards of four thousand four hundred, of which about eighteen hundred have licenses. Their annual take averages from a million and a half of *yen* to two million value, and it is estimated that with more diligence and improved methods they might easily bring this figure to three or four millions.

IT is rather surprising that tobacco has been so little cultivated in Australia. The *Agricultural Gazette* of New South Wales, we are glad to see, has taken up the matter, and in its November number devotes to it a comparatively long and interesting paper. The writer of the article thinks that the climate of New South Wales is admirably suited to the growth of tobacco, and hopes that a sufficient quantity of it may hereafter be produced not only to satisfy local demands, but to open up a large and lucrative export trade.

ONE of the curious survivals of ancient prejudices in India is the intense dislike with which many high caste Hindus regard sea-voyages. It is even disputed whether a Brahmin who takes a sea-voyage does not lose caste. The Maharaja of Mysore has not only emancipated himself from this strange notion, but is doing his best to overcome it in others. He lately made a voyage to Calcutta, and took with him a number of orthodox Brahmins, as well as Brahmin officials of state.

MR. WALTER HOUGH, of Washington, notes in *Science* that among the collections from Mexico, Central and South America, exhibited in the Columbian Historical Exhibition at Madrid, he observed a number of oblong polished blocks of hard stone of unknown use, averaging $3\frac{1}{2}$ inches in length, $2\frac{3}{4}$ inches in width, and $1\frac{1}{4}$ inches in thickness. The broad sur-

faces of these stones are plane, bearing a number of grooves parallel to the length, forming ridges like those seen on Polynesian tapa mallets. The implements resemble closely, he thinks, those used by many different peoples in beating out fibrous bark for clothing, paper, &c. Mr. Hough suggests that they may have been used for purposes of this kind in prehistoric times, and that they may give some insight into the manufacture of the paper on which the Mexican codices are painted.

MUD GORGE, on the Hurnai route to Quetta, has been giving much trouble to the engineers engaged in the construction of the new railway. Landslips are frequent, and an unusually bad one has occurred within the last few weeks. On this occasion the hill, according to the *Pioneer Mail*, slipped in such a way "as to lift the rails bodily up and turn them over, sleepers uppermost." The mountain is said to be a great porous mass of clayey soil with large boulders imbedded therein, and it sucks in moisture like a sponge. After heavy rain it begins to move downwards, and even in dry weather disintegration goes on with disastrous results to the railway. New fissures are reported to have appeared hundreds of yards up the slopes above the line, and each of these indicates that thousands of tons of earth and boulders will sooner or later find a lower level. A committee of experts has been appointed by the Indian Government to examine the mountain thoroughly, and the *Pioneer Mail* truly says that "if they succeed in devising a means to conquer it they will achieve a notable feat in engineering."

DR. LOW, President of Columbia College, New York, has been stating in the American *Educational Review* his impressions as to the condition and tendencies of the higher education in the United States. One of the points on which he strongly insists is that a general college training should be considered necessary before students begin their University education in theology, law, and medicine. "The prophetic eye," he says, "can even now discern the day when a college education will be a condition precedent for entrance into the professional schools of the American university. This will not mean that only college-trained men will make good practitioners in law or medicine, for example, nor that only college-trained men are entitled to a professional education. It will rather mean, I think, that the university will then have fully realised its own obligation to the country to send forth into professional life, in all parts of the land, men of a thorough and wide equipment."

ARCHÆOLOGISTS have observed that in Greek statues the male eye is strongly arched, while the female eye has rather a flattened surface; and referring to accounts by the older anatomists who have affirmed such a difference to exist, they have seen in this a fresh proof of the exact observation of nature by the ancient Greeks. The rule is not without exceptions, for the cornea in the Zeus of Otricoli has quite a flat form. Herr Greef recently set himself (*Archiv für Anat.*) to inquire whether such a sexual difference actually exists, and from individual measurement of the radius of the cornea in the horizontal meridian, he gets an average of 7·83 mm. for men, and 7·82 mm. for women (Donders gives 7·858 and 7·799), so the difference is so small as to be imperceptible to the naked eye. Measurement of other dimensions gave but minute differences also. The author concludes that the Greeks (from artistic motives) did not in this case follow nature.

THE difference between the aspect of the sky at full moon and the clear and deep azure observed on a moonless night is explained by M. Clémence Royer in his "Recherches d'Optique Physiologique et Physique" on the basis of some observations made by M. Piltschikoff. In studying the polarising action of the moon on the atmosphere, the latter found that the proportion of polarised light in the nocturnal sky diminishes continuously from the time of the full moon up to that of the new moon, when it becomes zero, subsequently to increase again until the time of full moon. There appears to be a struggle between the polarised light of the moon and the so-called natural light of the stars, and the proportion of polarised light sometimes reaches 62 per cent. The diffusing power of the atmosphere necessarily varies with the relative proportions of natural and of polarised light, since the latter is not capable of reflection in all directions. Hence we see why very serene but moonless nights may yet be relatively very clear, and the sky of a beautiful sombre blue, whereas the white light of the moon, reflected, diffused, and polarised, tends to give the sky a tint of a paler and somewhat greyish blue.

AT the last annual meeting of the American Association of Official Agricultural Chemists, the Proceedings of which have just been issued, Mr. N. T. Lupton referred in his presidential address to the immense phosphate beds in the south-western part of Florida. Last winter a visit was paid to some of the localities where deposits are found, and samples were collected for analysis. They were of two varieties, which may be called hard and soft. The hard variety consists of boulders of moderately hard rock, some of immense size, cemented together with white clay. A white and friable mass resembling kaolin is occasionally found. This is probably produced by the natural disintegration of the hard rock by rolling, attrition, or concussion. The deposits vary in thickness. A depth of 20 or 30 feet is not uncommon, and even a thickness of 50 feet has been found. As some, especially foreign, manufacturers object to buying phosphates which contain over 3 per cent. of oxides of iron and aluminium, large quantities of these materials have accumulated at the mines. A few manufacturers, aware of the agricultural value of South Carolina floats, have established mills in Florida for pulverising these soft aluminous deposits, which are sold to farmers for use without conversion into soluble phosphates. Experiments are now in progress on the Alabama Experiment Station, under control of the chemist, to determine the chemical composition and agricultural value of these soft phosphates when used alone with cotton seed and with cotton-seed meal. If decomposing organic matter, as is believed, renders insoluble phosphates available as plant food to any considerable extent, Mr. Lupton thinks that the question of cheap phosphates will be solved, and that the American farmer will be enabled to purchase fertilisers at a much less cost than at present.

MESSRS. W. H. ALLEN AND CO. have issued the thirty-seventh thousand of Dr. M. C. Cooke's "Manual of Structural Botany." The book is intended for the use of classes, schools, and private students.

THE February number of *Natural Science* includes, among other things, articles on some problems of the distribution of marine animals, by Otto Maas; on Pasteur's method of inoculation and its hypothetical explanation, by G. W. Bulman; the industries of the Maoris, by J. W. Davis; some recent researches on insect anatomy, by G. H. Carpenter; parasites on algæ, by G. Murray; the underground waste of the land, by H. B. Woodward; Owen (concluded), by A. S. Woodward; and the restoration of extinct animals.

THE following are the arrangements for science lectures at the Royal Victoria Hall during February:—Feb. 7, Mr. J. Scott Keltie, on Africa and its people; Feb. 14, Mr. E. Wethered, on interesting objects under a microscope; Feb. 21, Mr. J. T. Leon, on breathing and burning; Feb. 28, Dr. H. Forster Morley, on chemistry of life.

THE additions to the Zoological Society's Gardens during the past week include seven Azara's Opossums (*Didelphys azaræ*)

from the Argentine Republic, presented by Mr. Hill; a Rough Terrapin (*Clemmys punctularia*) from Guiana, presented by Mr. J. J. Quelch, C.M.Z.S.; an American Milk Snake (*Coluber eximius*) from Tennessee, presented by Miss Winifred M. Middleton; a Virginian Eagle Owl (*Bubo maximus*) from South America, deposited; two Mouflons (*Orlis musimon*, ♂ ♀) from Corsica, received in exchange.

OUR ASTRONOMICAL COLUMN.

THE NAUTICAL ALMANAC FOR 1896.—The new superintendent of the *Nautical Almanac* office has introduced a much-needed reform into the first almanac, that for 1896, issued under his direction. The state of the *British Nautical Almanac* has long been severely criticised as being far from the best possible for navigational purposes both in form and contents, and by no means satisfactory from the astronomical standpoint. A letter addressed by the Shipmasters' Society to Dr. Hind, the late Superintendent, in November 1891, pointed out the advantage to navigators which would be offered by a work published at a popular price, and without that astronomical information which is of no use to sailors. Many low-priced almanacs are published, indistinctly printed, and having occasional errors in the figures, and an official trustworthy book was very desirable. In consequence of this representation the almanac is now published in two forms—as the complete almanac of former years, price 2*s*. 6*d*.; and as Part I. of the *Nautical Almanac*, specially suited for the use of sailors, price 1*s*.

The complete almanac has been revised and added to, many of the recommendations of the *Nautical Almanac* Committee of the Royal Astronomical Society, which reported to the Admiralty in 1891, having been adopted. The small short period terms of nutation have been tabulated, and, corresponding to that, additional day numbers are added so as to enable computers to include those small terms in the star corrections. The catalogue of stars from which the moon culminators and stars occulted by the moon are obtained has been revised and enlarged, and the mean places of the stars of this catalogue, which are used during the year, are also included. The elements of the occultations are given in a revised form similar to that adopted in most of the other astronomical ephemerides, so that the circumstances of an occultation for any position on the earth's surface can be computed with facility. There has been a general revision of the constants used.

The small almanac has been arranged by Mr. Downing in conference with the Hydrographer. As the guiding principle in publishing this was the minimum of change in the parts of the almanac which were to be extracted and published separately, there is still much in the volume that is not needed by sailors, but the omission of which would have necessitated the setting up of fresh type and much extra work at the *Nautical Almanac* office. The monthly part is printed unaltered, and consequently contains the sun's and moon's latitude and longitude, which are not required by sailors. The noon ephemerides for the brighter planets, Venus, Mars, Jupiter, and Saturn; the catalogue of mean places of stars, as well as the apparent places of the nine stars used for lunar distances; the eclipse section and the tables for navigation are then given. There is no doubt that the issue of this smaller work will confer a real benefit on the shipping community, and that it will soon win its way to popularity.

In announcing these changes to the Royal Astronomical Society, Mr. Downing expressed the hope of being able, through the economy of time effected by international co-operation in some of the work of the office, to make considerable future additions to the almanac without increasing the burden of the British taxpayer. The duplicate work done at Berlin, London, Paris, and Washington involves much waste of energy which might be more usefully expended: and as a step towards this, Mr. Downing, last summer, arranged with Prof. Newcomb, of Washington, to co-operate in some of the work of their respective almanacs, and the Admiralty have consented to this. It is to be hoped, in the interests of astronomy and of navigation, that the scheme may be greatly extended.

ECLIPSE PHOTOGRAPHY.—The results obtained by M. de la Baume Pluvinel at Salut Isles in 1889 (as given in his lecture which appeared in NATURE last week), when he photographed the corona with photographic actions varying from 185 to 13, and found the photographic action of ·30 the most satisfactory; do not agree with those of the English expedition obtained at the same time and place. The photographic actions on the plates exposed with the 20-inch mirror of 45-inches focus, by the late Father Perry, varied from 19·75 to 790· as calculated by the formula given by M. de la Baume Pluvinel, and in every case increase of photographic action gave greater extension of the corona. Mr. Rooney's plates, with the 4-inch lens of 61 inches focus, had been subjected to photographic actions varying from 1·11 to 177·77, and agreed with Father Perry's in giving greater extension with every increase of photographic action. The English results certainly justify the conclusion that greater photographic action is necessary to photograph those faint extensions of the corona which have been seen, but have hitherto eluded attempts to photograph them.

Mr. Burnham's experiments, alluded to by M. Pluvinel, do not assist us in this question. A certain absolute amount of light is necessary to give *any* appreciable photographic effect on the plate, and this seems to be the chief difficulty in obtaining photographs of the external corona. In Mr. Burnham's experiments he had too much light and had to cut down the exposure in order to get faint contrasts, but there was never any question of not having sufficient light to obtain any photographic effect. Captain Abney finds (Phil. Trans. vol. clxxx. A, page 314) that an abrupt change of ½ per cent. in the intensity of light can be detected on a photograph, hence we may look upon a negative as a drawing built up of 200 different shades. Over exposure will of course prevent such faint contrasts as ½ per cent. being detected, and under exposure will enable fainter contrasts to be seen, *so long as the limit of minimum exposure necessary to produce any photographic effect is passed*; but the evidence from the English expedition renders it extremely probable that even with the largest photographic action used this limit was not actually reached with the faintest extensions of the corona.

COMET HOLMES.—Dr. F. Cohn, writing about this comet from the Observatory in Königsberg on January 17, finds (*Astronomische Nachrichten*, No. 3146), with a 6-inch heliometer and a magnification of 65 times, that the nucleus is exactly as a star of the 8th magnitude. The correction to the ephemeris given below is, as he has deduced, $\Delta\alpha = -0{\cdot}3$s., $\Delta\delta = -6''$.

Dr. R. Schorr, of the Hamburg Observatory, puts the nucleus down on the same date as a 7·2 magnitude star with a small nebulosity about it of 5″ diameter, but on the 18th he found the comet showed a much larger coma, a measurement giving 87″. The stellar nucleus was also estimated as 7·5 magnitude of a diameter 2″.

The ephemeris of this comet is from Prof. Schulhof's calculations (*Astronomische Nachrichten*, No. 3140):—

1893.	R.A. app. h. m. s.	Decl. app. ° ′ ″
Feb. 2 ...	1 45 46·5 ...	+33 49 26
3 ...	47 16·6 ...	50 48
4 ...	48 47·3 ...	52 14
5 ...	50 18·6 ...	53 45
6 ...	51 50·4 ...	55 20
7 ...	53 22·8 ...	56 59
8 ...	54 55·8 ...	58 41
9 ...	1 56 29·3 ...	34 0 28

COMET BROOKS (NOVEMBER 19, 1892).—The following is an ephemeris for Comet Brooks for the ensuing week:—

1893.	R.A. app. h. m. s.	Decl. app. ° ′	Log *r*.	Log Δ.	Br.
Feb. 2 ...	23 56 48 ...	+34 27·7			
3 ...	23 59 13 ...	33 44·4 ...	0·1050 ...	0·1295 ...	1·90
4 ...	0 1 31 ...	33 3·3			
5 ...	3 42 ...	32 24·1 ...	0·1087 ...	0·1482 ...	1·71
6 ...	5 48 ...	31 46·4			
7 ...	7 48 ...	31 10·4			
8 ...	9 43 ...	30 35·8			
9 ...	0 11 33 ...	30 2·9 ...	0·1167 ...	0·1832 ...	1·40

THE ANDROMEDES.—Although Mr. Maclair Boraston was unfortunate in having bad weather on the nights of November 13 and 14 last, thus obscuring the Leonids, yet the magnificent shower of the Andromedes that he describes in *Astronomy and Astrophysics* for January should have recompensed him somewhat for "the great elevation of the radiant point, combined with a cloudless tropical sky, the absence of moonlight and the unobstructed view of the complete hemisphere, afforded the *ne plus ultra* of astronomical requirement." Observing in

longitude 72° west and latitude 17° north, between 11h. 48m. and 5h. 48m. G.M.T., he deduced the radiant point from 70 short-track meteors, and four coincident stationary ones, giving its position as R.A. 28°, decl. + 36°. Counts being taken at intervals for areas of 60°, about 18 meteors per minute were recorded, thus making a total number of 108 for the entire hemisphere in one minute, or 6480 per hour. As this fall went on continuously for six hours without any sign of the numbers diminishing, we have the number of meteors 38,880, which Mr. Boraston says must certainly be a minimum, as many faint and rapid ones must have escaped notice. A further observation at 8h. 48m. showed that the action was still being kept up, thus increasing this number to about 60,000. During this display it was remarked that the meteors appeared much brighter when distant from the radiant point than in its vicinity.

A NEW METHOD OF PHOTOGRAPHING THE CORONA.—M. H. Deslandres, in the *Comptes Rendus* of January 23, describes a method of photographing the solar corona without the aid of absorbing media. Sunlight is allowed to fall directly on a system of two identical prisms with parallel and inverted faces placed at a distance apart, such that only a portion of the diverging band from the first is intercepted by the second. After passing through the latter, the rays by recomposition give rise to a well-defined coloured image of the sun's disc. On displacing the prisms in a line perpendicular to the line joining them, the image assumes different colours, and on moving them along it, the range of colours intercepted is made to change. The prisms may be replaced by gratings. In a series of experiments carried out during the autumn, nine successive impressions of the sun's image were taken, ranging from the C line till far into the ultra-violet. The object was to find the region where the light emitted by the corona showed the greatest photographic difference from that of the diffused sunlight in the atmosphere. As a matter of fact, a halo distinctly separated from the diffused sunlight showed itself on some of the negatives, especially in the ultra-violet region, which very probably represented the corona. But to confirm this, simultaneous exposures at different, especially elevated, stations ought to be made, if possible during a total eclipse.

GEOGRAPHICAL NOTES.

THE February number of the *Geographical Journal*, in addition to two important papers read before the Royal Geographical Society, and already reported in NATURE, contains a brilliant account by Mr. Conway of the crossing of the Hispar Pass. The views of mountain scenery were bewildering in their extent; from the foot of the valley an unbroken glacier was in sight, stretching downward from the pass forty miles distant. This unrivalled ice-stream was covered for the lower twenty miles with moraines. From the pass a vast snowfield, surrounded by magnificent rock aiguilles, was seen to lie below, and from this the Biafo glacier descended. From the end of the Hispar glacier to the end of the Biafo glacier was a distance of eighty miles, forming the longest snow-pass in the world outside the Polar regions. Mr. Stephen Wheeler communicates a paper on Mendez Pinto, whose early travels in the East seem to have been unduly discredited.

IT is announced that the eminent geographical author M. Elisée Reclus has accepted a professorship in the University of Brussels, and will commence his work there by a course of lectures on comparative geography.

MR. ASTOR CHANLER'S expedition to Lake Rudolf, by the Tana, has reached Hameye, the Ibea Company's post at the head of navigation on the Tana—a position accessible in five weeks from the coast, to which camels, oxen, donkeys, and horses can be safely taken. Lieutenant Höhnel, who is attached to the expedition, finds that Commander Dundas has placed the Tana from 20 to 22 minutes of longitude too far west, and he has searched in vain for the mountain ranges reported by Dr. Peters.

IN a recent journey of some duration in the Sakalava plain in the north-west of Madagascar, M. Emile Gautier (according to the *Annales Géographique*) found the soil everywhere to consist of a stiff red clay, weathered into steep-sided lumps and chasms overlying sedimentary rocks, but quite similar in colour and character to the red clay which covers the volcanic rocks of the plateau. M. Gautier believes that this clay is identical with the laterite of the Deccan.

MAJOR LEVERSON, the British Commissioner for the delimitation of the frontier between the British South Africa Company's territory and the Portuguese possessions, has returned to this country, after having carried out extensive surveys and made considerable rectifications in the map of a strip of country stretching from the north-east corner of the Transvaal northward to Massikesse. The position of the latter point was fixed as 18° 15′ 33″ S., 32° 51′ 24″ E.

MR. MACKINDER gave the second lecture of his course on History and Geography, under the auspices of the Royal Geographical Society, on Friday evening, when he discussed the road to the Indies, showing how the desert route, which led to the growth of Palmyra, was superseded by the ocean route after the successful rounding of the Cape of Good Hope. The theatre of history in ancient times was the region enclosed between the pine forests of northern Asia and the Indian Ocean, divided into separate worlds by a double belt of deserts and steppes.

THE GROWTH OF ELECTRICAL INDUSTRY.

ON Friday last Mr. W. H. Preece, F.R.S., delivered before the Institution of Electrical Engineers his inaugural address as President. He said he had completed his fortieth year of continuous service in developing the practical applications of electricity for the use and convenience of man, and it appeared to him that he could not better repay the high compliment the Institution had conferred on him by electing him, for the second time, to be its President than by surveying and criticising the growth of the various branches of electrical industry with which he had been more or less associated during that long period. In the course of his address he dealt with telegraphy, submarine telegraphy, lightning protection, railway signalling, telephony, domestic applications, electro-chemical industry, electric lighting, power transmission, electric traction, and theoretical views of electricity.

Speaking of telegraphy, Mr. Preece said:—The instrument that we have principally developed in England is the automatic fast-speed apparatus, based on a principle of preparing messages for transmission by punching, devised by Alexander Bain in 1848, and improved in its mechanical details by Mr. Augustus Ströh in 1866. This has been my special pet, and with the electrical assistance of Mr. J. B. Chapman, and the mechanical skill of Mr. J. W. Willmot, all the ills that telegraphs are heir to have been routed, and the practical speed of working has been multiplied more than six-fold. It has been one long continual contest between patient observation, inventive skill, careful experiment, and technical acquirement on the one hand, and resistance, electrostatic capacity, inertia (electro-magnetic and mechanical), bad insulation, impure materials, imperfect workmanship, &c., on the other. But we have, step by step, won all along the line: 75 words per minute have become 500; a possible 130 has become an actual 600. Duplex automatic working over cable lines is possible, and modes of working have been introduced that were thought at one time chimerical and impossible. . . .

The results to which I have referred have not been attained without very special attention to questions of construction and maintenance of the wires, both aerial and submarine, and a very complete system of test is now applied both before and after every line is completed. In the early days of telegraphic communication very rough and crude tests were applied, and the condition of the lines caused serious difficulties; but at the present day we must ascertain the purity of the metal employed, its mechanical strength, its electrical resistance and capacity, its insulation resistance, and the relationship between the latter and the conductor resistance, as well as its speed value. The employment of copper as the conductor suspended on poles in place of iron, which was inaugurated at my instigation in 1884, by a very costly experiment between London and Newcastle, has had a material influence in increasing the speed of working and improving telegraphy. This is due not only to its reduced resistance, but to the absence of electro-magnetic inertia in a long, single-suspended copper wire. All our long important telegraphic circuits are now built with copper.

One of the arguments used against the proposed transfer of the telegraphs to the State was the notion that invention would not be fostered by a Government department. This has been entirely falsified. Telegraphy has been advanced in this country

more rapidly by the British Post Office than by any private undertaking, and we have certainly shot ahead of our smart cousins on the other side of the Atlantic, from whom, however, I am proud to say, I learnt so much on my visits in 1877 and 1884. Their engineers are looking to us to develop their inventions, and we have done so. They cannot always get them taken up in the States. Diplex, quadruplex, and multiplex telegraphy are importations from them, but they have been improved in our service by our own developments, and have now become the staple and the standard modes of working. No one has done more to effect this object than Mr. M. Cooper.

An accident in the drafting of the Act of Parliament of 1868-69 transferring the telegraphs from the hands of private companies to that of the State, has led to a tremendous development of newspaper reporting in England. Few people are aware of the immense business done for the press. The growth of press messages is shown in the fact that 21,701,968 words paid for in 1871 have grown in 1891 to 600,409,000—an average of nearly 2,000,000 words per day.

When Mr. Gladstone spoke at Newcastle, at the National Liberal Federation, in 1891, 390,778 words were signalled to different parts of the country. This kind of business is not, however, confined to the Post Office. The Exchange Telegraph Company, which commenced operations in 1872, working under the license of the Postmaster-General, has in London over 800 instruments at work (120 being in newspaper offices), distributing a daily average of 3,381,134 words to various receiving instruments adapted to the requirements of the respective services. The financial intelligence, for example, being transmitted over instruments furnished with type-wheels containing the various fractions most in use in Stock Exchange quotations. The latest form of this instrument prints at the rate of forty words per minute. General and parliamentary intelligence are distributed to the clubs over column printers, and legal, sporting, and Parliamentary news to newspapers on specially fast tape printers, capable of delivering, in the hands of skilled operators forty-five full words per minute to any number of subscribers simultaneously. The news transmitted is chiefly commercial and financial, amounting to 2,775,000 words per day.

To return to the purely State telegraphy. Some idea of the growth of the general telegraphic business of the country may be gathered from the following statement, which gives the total number of messages paid for in each year :—

1852	211,137
1869	6,830,000
Transfer took place in 1870.	
1882	31,345,861
1892	70,215,439

In the course of his review of the history of submarine telegraphy, Mr. Preece said :—By far the greatest cable corporation in the world is the Eastern Telegraph Company, whose system of 25,376 miles stretches from Cornwall to Bombay, connects the northern and southern shores of the Mediterranean with Malta, and joins up the various other islands of the Mediterranean and the Levant. This company, in conjunction with the Eastern Extension and the Eastern and South African Companies, also gains access to Australia and New Zealand on the one hand, and to the Cape of Good Hope on the other, the combined mileage reaching a total of no less than 47,151. This enormous system has all grown up within, practically, the last 23 years.

The form of cable has practically remained unaltered since the original Calais cable was laid in 1851. Various sizes of core and armour, and various modes of protection from decay, have been used to suit different routes, but the cable of to-day may be said to be typically the same as that used in the English Channel in 1851, and in the Atlantic in 1865.

The first cable had gutta-percha as a dielectric, and it is still almost exclusively used for submarine cable core ; but the manufacture has so improved in the last twenty years that a core having an insulator weighing 150 lbs. per naut, which then had a dielectric resistance of some 250 megohms a naut at 75° F., can now be obtained, giving 2000 megohms at the same temperature. Indiarubber is creeping in, owing to the high price and scarcity of gutta-percha.

Next to strong tides, rocky bottoms, anchors, and shallow water, the greatest enemy to submarine cables, more especially in the tropics, has proved to be the teredo of various species ; but this depredatory worm has been utterly routed by covering the gutta-percha core with a lapping of thin brass tape laid on spirally. A remarkable thing about this little insect is that, whereas twenty years ago it was practically unknown in our English waters, it has now gradually spread all round our coasts, with the exception, perhaps, of the North Sea. A new cable about to connect Scotland and Ireland is being served with brass tape.

With the cables has grown up a fleet of telegraph ships to lay and maintain them. In 1853 the *Monarch*, belonging to the Electric Telegraph Company, was the only ship permanently employed as a repairing telegraph ship ; now, in 1893, the cable fleet of the world numbers no less than 37, of which seven belong to Government administrations and the rest to private companies, the Eastern Telegraph Company heading the list with five vessels.

Perhaps the most remarkable history of a cable is the following :—In 1859 the light cables laid in 1853 from Orfordness to Holland were picked up and replaced by a heavier one. A few nauts were sold to the Isle of Man Telegraph Company, and had an extra sheath laid on. This cable was submerged between that island and St. Bees, where it remained until 1885, when it was replaced by a three-core cable. It was again put under water in 1886 as part of the cable between Uist and Harris, in the Hebrides, where it still lies, as good as ever. The durability of submarine cables is remarkable. That laid between Beachy Head and Dieppe in 1861 is still working ; and that laid between Beachy Head and Havre in 1870 has broken within the last month for the *first* time.

Despite the enormous growth of submarine cables during these forty-two years, there would appear to be plenty of scope for still further extension. The Pacific still remains untouched, and the project is at the present time under consideration to connect our possessions in North America with those in Australia.

The following is the passage relating to telephony :—I had the good fortune in 1877 to bring to England the first pair of practical telephones. They had been given to me in New York by Graham Bell himself. After a series of experiments, I brought them before the British Association meeting, which was held that year at Plymouth. Who at that time could have imagined that the instruments, which were then but toys, would, within sixteen years, have become a necessity of commercial, and almost of domestic, life ? Yet to-day the number of telephones in actual use may pretty safely be put down at a million !

During 1878 Edison devised his carbon transmitter, and Prof. Hughes presented his "microphone" to the world. These inventions made the telephone a practical instrument of vast commercial importance. It may be said to have sprung into existence well-nigh perfect ; and the fewness of the actual improvements on the Bell receiver and the Hughes microphone is scarcely more astonishing than the immense number of fruitless attempts at improvement that have been made. Even now the original instruments are not easily beaten.

The institution of telephone exchanges has led to a development of systems of switching that might fairly be considered a special study in themselves, and the demand for communication between distant places has necessitated the application of much special attention to the method of constructing lines and of arranging circuits.

It is in this latter field that I have been a diligent worker, and the application of the so-called "K R" law has proved of material benefit in connection with the problems of long-distance telephony. It is a law which implies that the number of signals that can be transmitted per second through any circuit depends solely on the capacity (K) and the resistance (R) of the circuit. It is very much the fashion to deny the accuracy of the K R law. This is probably the result of ignorance of its meaning or of its interpretation. Some speak of it as empirical, others scoff at it as imaginary, and some sneer at it as an impossible law ; but it is a law that has determined the dimensions and speed of working of all our long submarine cables ; it determines the number of arms a circuit can carry on the multiplex system, the speed attainable with the Wheatstone system, and the distance to which it is possible to work quadruplex ; it is a law that has enabled us to bring London and Paris within clear telephone speech of each other, and which will probably before the year is out enable Dublin and Belfast to speak to London—a message

of peace to Ireland as solid and substantial as any promised political proposal.

The New York and Chicago trunk line is 950 miles long, and it is built with 435 lbs. (or No. 8 S.W.G.) copper wire. This wire gives a resistance of 2·06 ohms per mile, which is easily verified; but it is said by Mr. Wetzler to have a capacity of 0·0158 microfarad per mile, which cannot be verified, and which is absurdly high. 0·0158 microfarad was a measurement made by me in England on an old line, but I have frequently pointed out that owing to the use of earth wires the capacity of our English lines is very much greater than that of American lines. Mr. Edison discovered this in 1872 when he came to England to introduce his automatic system. Moreover, I have also pointed out that induction still further diminishes this capacity. The Paris circuit does not exceed 0·005 microfarad per mile. I should estimate the Chicago circuit at 0·004 microfarad per mile, and the K R at 7500, which gives a result that quite accords with the opinions that I have heard expressed by those who have tried the two circuits as to the relative efficiency of the Paris and Chicago lines. My American friends would have done better if they had used thicker wire. I should have specified 600 lbs. per mile; but if it had been in England I should have used 1000 lbs., for we cannot dispense entirely with cables and underground work as they have done in the States, and the increased capacity introduced must be compensated for by reduced resistance. As a matter of fact, I once proposed 1200 lbs. wire for a circuit between London and Berlin—a distance of 760 miles, including a cable 55 miles long.

The beneficial effect of induction as a negative capacity is observed when working a circuit telegraphically with automatic high-speed apparatus. Thus, on two copper wires 450 miles long, making 900 miles altogether, the speed on each single wire was 120 words per minute, and on metallic circuit—

Loop *viâ* different routes	...	120 words per minute.
,, on same poles ...	...	150 ,, ,,

So that the improvement effected by induction was 25 per cent.

There is no difficulty in measuring R of a metallic loop. The Wheatstone bridge determines it at onee. There is more difficulty in obtaining K. It cannot be measured directly. But with a metallic loop of copper, partly overhead and partly underground, there are several modifications required, due to electrostatic and electro-magnetic induction, which are at present beyond the reach of formulæ, and render it difficult to determine the capacity except approximately from the telephonic effects themselves. Thus the capacity on the London-Paris circuit proved to be only one-half of that obtained by calculation, and every long circuit will require its own K to be determined by comparison with an empirical K R scale. Such a scale I have determined by careful experiment on artificial cables.

I have recently devised a new form of cable which will probably quadruple the rate of telegraph working to America; and I may say with all confidence that there is no theoretical reason whatever why we should not converse between London and every capital in Europe, while it is not impossible to speak even across the Atlantic.

With regard to electric lighting, Mr. Preece said that many efforts are being made to utilise the waste forces of nature in producing electric currents for the economical supply of the light. In America, Scotland, Switzerland, Italy, and, indeed, wherever waterfalls are available, electric plant is being installed to convert the energy of the fall into the useful form of electricity. At Tivoli, near Rome, a fall of 165 feet is used to work six turbines of 350 horse-power each, giving 2100 horse-power in all. Six high-pressure alternators working in parallel send electrical energy at over 5000 volts pressure to Porta Pia, near Rome, 14·8 miles from Tivoli, through four stranded copper conductors, each having a diameter of 13mm., and bunched into one metallic loop, giving a total resistance of 4 ohms. At Porta Pia the 5000 volts are reduced to 2000, and the currents are distributed to several substations spread over the city, where they are again lowered to the safe pressure of 102 volts, at which voltage the current is supplied to the consumer on the three-wire system. There are 600 arcs and 30,000 glow lamps in use in Rome, but they are not all supplied from Tivoli. Mr. Preece inspected this installation only a few days ago, and found everything working smoothly and efficiently under the able guidance of Prof. Mengarini.

Water power abolishes the coal bill, but it must be remembered that the cost of maintenance of machinery and of the erection and upkeep of conductors limits the distance to which the energy of falling water can be economically transmitted. The proposal to light New York by currents generated at Niagara is at present financially absurd. It is doubtful whether it will be commercially advantageous at Buffalo, 30 miles away, but it is certain that at Tivoli it can be so applied with advantage and profit.

There is much water power in this country that might be usefully employed. At Worcester it is proposed to use the water of the Teme, a tributary of the Severn, to supply electrical energy to the city—an experiment that will be watched with considerable interest, for the use of water power will solve the difficulty occasioned by light loads during the small hours and daylight. Keswick and Lynton have already been so served, but on a small scale only. There are many towns whose public streets could be brilliantly illuminated by the streams running past them, but there is much fear and distrust to be removed from the minds of our local magnates, and a considerable amount of education necessary before the public will receive the full value of the gifts that nature so freely places at its disposal, and the engineer so thoroughly converts into a utilitarian form.

The following are some extracts from the passage in which theoretical views of electricity are discussed:—

In the Presidential address which I delivered to the Society of Telegraph Engineers and Electricians in 1880, I took the opportunity to formulate the theoretical views of electricity that I had acquired at the feet of Faraday. It is not given to every boy to have his great ambitions realised. One of my ambitions as an earnest listener to Faraday's simple and delightful lectures was to be his assistant, and in almost the last investigation he undertook on electric induction in underground wires it was my privilege to see much of him, and to prepare many experiments for him. Early in 1854, at his wish, I carried out for Mr. Latimer Clerk certain experiments on the comparative effect of increments of voltage in increasing the rate of transmission of signals through long telegraph circuits. It was found that variation of voltage had no effect. Currents from 31 and from 500 cells sent through 768 miles of gutta-percha-covered underground wire showed precisely the same velocity. These experiments were sent by Faraday to Melloni, who had prompted the wish, and Melloni ("Faraday's Researches," vol. iii. page 577) remarked: "The equal velocity of currents of various tensions offers a fine argument in favour of the opinion of those who suppose the electric current to be analogous to the vibrations of air under the action of sonorous bodies." This is to be found in the very last contribution inserted in the greatest work ever published on our science, "Faraday's Experimental Researches in Electricity."

Faraday's views were subsequently expounded and extended by Maxwell, who said: "Faraday, in his mind's eye, saw lines of force traversing all space, where the mathematician saw centres of force attracting at a distance; Faraday saw a medium where they saw nothing but distance; Faraday sought the seat of the phenomena in real actions going on in the medium, they were satisfied that they had found it in a power of action at a distance impressed on the electric fluids" (Maxwell, "Electricity," vol. i. page 10).

Since that period I have never regarded electricity as anything else but as a form of energy, and its effects as modes of motion of the molecules of matter and of the ether that fills all space; and during my long apprenticeship of forty years I have never examined one experiment or considered one fact that was not explicable on this theory. . . .

Electricity is energy which is transmitted by matter and through space by certain disturbances the result and the equivalent of work done, and in certain orderly and law regulated forms, called "electro-magnetic waves." It is not difficult to conceive the ether carved or the molecules of matter swayed or excited in definite periodic waves. A molecule is subject to all kinds of motion—translation, oscillation, rotation upon its own axis, and revolution about some external axis. Clausius (*Pogg. Ann.*, clvi. p. 618) suggested that the atoms or groups of atoms constituting a molecule revolve around one another similarly to planets, and are sometimes nearer to and sometimes further from each other. The difference between the infinitely great and the infinitely little is only one of degree. The motions of the solar system and that of a molecule of water are similar. These motions are imparted to and transmitted by

the ether, and they are taken up again by matter. One kind of wave gives us light, another radiant heat, another magnetism, and another electrification. The rate at which these waves move is the same, viz. 30,000,000,000 centimetres, or 192,000 miles, per second. It is only their form and their frequency that differ. Matter and ether are subject to strains, currents, vortices, and undulations, and every single electro-magnetic phenomenon can be compounded of or reduced to one or other of these mechanical disturbances. Rotation in one direction gives positive electrification: rotation in the opposite direction gives negative electrification. A whirl in one direction gives us north magnetism; in another direction, south magnetism. Hertz, the experimental exponent of Maxwell's views, has shown the existence of electro-magnetic waves, and has proved their reflection, refraction, and interference. The rate of their propagation is the same in ether, air, and conducting wires.

The most recent discoveries and deductions are all in accordance with this mechanical theory. J. J. Thomson's views that at high temperatures, in the act of dissociation, all gases, and Dewar and Fleming's conclusion that at low temperatures—in fact, at the absolute zero of temperature—all metals become perfect conductors, might almost have been predicted. Hysteresis and Foucault losses are mere wastes of energy, due to molecular friction or to internal work done on the molecules, assisted by bad design and impure material; but, being measurable and comprehensible, their reduction to a minimum has become possible and actual.

It is a misfortune that a beautiful hypothesis like Maxwell's electro-magnetic theory of light has been discussed almost solely by mathematicians. Its consideration has been confined to a small and exclusive class. It has not reached the public; and this is to be regretted, for, after all, it is the many, and not the few, that determine the acceptance or refusal of a theory. The existence of the ether is now thoroughly comprehensible. Light is now regarded as an electro-magnetic disturbance. The eye is an extremely sensitive and delicate electro-magnetic instrument. The difference between luminous, thermic, and electro-magnetic waves is one of frequency and form. We thus have to consider the propagation of these waves not only in the conductor and in the dielectric in the direction of the circuit itself, but in the ether at right angles to this direction. The former produces currents in the conductor, and the latter induction and secondary effects in contiguous conductors. Thus it is easy to see why electric and magnetic lines of force are at right angles to each other, and each of them perpendicular to the line of propagation of the primary electro-magnetic wave, and why the transversal disturbances are secondary waves of electro-magnetic energy which can be transformed into electric currents of opposite direction whenever contiguous conductors lie in their path so as to be cut by these lines of force in the proper direction. Induction is thus mere transformation of energy whose direction and magnitude are easily calculated.

It is by following out this line of thought that I have recently succeeded in sending messages by Morse signals across the Bristol Channel between Lavernock and Flat Holm, a distance of 3·1 miles. The electro-magnetic disturbances were excited by primary alternating currents in a copper wire, 1237 yards long, erected on poles along the top of the cliff on the mainland. The radiant electro-magnetic energy was transformed into currents again in a secondary circuit, 610 yards long, laid along the island. The strength of these secondary induced currents complied almost exactly with calculations. The results attained, the apparatus used, the precautions taken to separate effects of induction from effects of conduction; the elimination of mere earth currents from electro-magnetic disturbances in air, will form the subject of a separate paper, for their proper consideration would be too tedious for an address. I allude to them now only to illustrate the existence of one of the greatest proofs of the truth of a theory, viz. the practical development and verification of a conclusion predicted from mere theoretical considerations.

The oscillatory character of the discharge of a Leyden jar, which was discovered by Henry in 1842, is an admirable proof of this molecular theory. If two jars, precisely similar as regards capacity and circuit inertia, be placed near each other with their planes parallel, and one of them is charged and discharged, the other responds sympathetically, as do two similarly pitched tuning-forks when one is excited. Professor Oliver Lodge, who has made this field his own, has shown that by varying the capacity of the jars and the inertia of the circuit, oscillations can be produced to give any required rate of oscillation from one to 300 millions per second.

In a room or theatre, when these discharges are excited, it is a common thing to see sympathetic sparks upon the spangled walls, and among the metallic objects scattered about. The whole place is an electric field, which is violently disturbed at every spark, and everything which is "syntonised," as Oliver Lodge calls it, to the main discharge, responds in this way.

It is impossible to account for these effects, which are all cases of transformed kinetic energy, except on the mechanical theory which I have advanced. We have a source of disturbance, we have energy transmitted in waves, we have wave transformed into disturbance again. Energy passes through its various stages by the motion of matter and the action of the ether. Everything is accounted for and nothing is lost. Waste energy only means energy in the wrong place.

YEZO AND THE AINU.

TWO papers on recent travels in the Island of Yezo were read to the Royal Geographical Society on Monday evening. Prof. J. Milne, F.R.S., whose paper was read by the Secretary, made a journey to the north-east of the island by sea in 1891, and returned by land, crossing Yezo almost through its centre. He was accompanied by Mr. John Revilliod, and travelled with a view to studying the volcanic geology of the regions. Landing at Kushiro, interesting on account of the relics of pre-Ainu inhabitants, and on account of its coal mines, they ascended the Kusuri river to Shibecha, where there is a great convict prison and sulphur refinery, the raw sulphur being obtained from the volcano Atosanobori, to which there is a railway twenty miles long. In this locality the violence of the escape of steam from the boiling springs exceeds anything seen elsewhere in Japan, New Zealand, or Iceland. A new road, thirty-seven miles long, led from the volcano to Apashiri, on the north-east coast, where a factory for making matches has recently been erected, on account of the abundance of the white-stemmed poplar, the timber of which is much more readily worked in the fresh state than when dried. A boat journey was made in a small dug-out canoe under rugged cliffs from 500 feet to 1000 feet in height, for thirty miles to Shiritoki, where there is a great sulphur mine. From some of the volcanic craters fused sulphur flows like lava, and crystallises in an almost pure state. A trip from Nemuro to the nearer Kurile Islands was followed by the main feature of the journey, a ride from Yubets, on the north coast, up the Yubets river, across the watershed, and down the Ishikari river, to the west coast. Groups of convicts working on the new roads, which are being made across the island, were almost the only people met with. Vast groves of tall bamboo grass everywhere impeded the travellers, and insects of all kinds proved very troublesome. There was little or no sign of larger animal life.

Mr. A. H. Savage Landor also read a paper. He had wandered all round Yezo and up several of the largest rivers quite alone, and with no object save curiosity and the desire to study the Ainu at home. The main part of his equipment was a great store of painting material, of which he made good use in portraying both the natives and the scenery of the island. The Ainu accessible from Hakodate, who have been frequently visited and often described, are almost all Japanese half-breeds, and much influenced in customs and costume by their southern neighbours. The Ainu of the interior and the more distant parts of the coast were very different. The true Ainu villages are intensely filthy, and the vermin in them make life almost unsupportable to a stranger, minute black flies, which swarm in incredible hosts, being the worst. The people, although good-humoured, are sunk in the most degraded savagery. Their marriage customs seem to be summed up in unqualified promiscuity, the Ainu disclaiming any idea of being better than bears or dogs. The Ainu language is poor in words, and many of them show a curious resemblance to words of Anglo-Saxon origin, *e.g. Chip*, for ship; *Do*, day; *Mukku*, music; *Pone*, bone; *Ru*, road; *To*, two; *Wakka*, water. The religious beliefs of the Ainu can hardly be dignified by such a term; they are merely superstitions. In travelling along the south-west coast there was often considerable danger from the waves washing over the narrow track which wound between the boulders on the beach. Fog prevails along the east coast in summer, probably on account of the Kuro-Siwo encountering a cold current off the island. The upper Tokachi river was the

most remote part of Yezo visited, a region which had scarcely been traversed by the Japanese. Here the Ainu were found to be more hairy than elsewhere, and to present many Aryan features in their general appearance. One peculiar fact brought out by many measurements was the remarkable length of their arms. The measurement across the outstretched arms is always from three to five inches more than the height of the individual. The future capital of Hokkaido (the name given to Yezo and the Kurile Islands collectively) is to be erected on the Kamikawa plain, in the very centre of Yezo, and roads are being pushed forward to connect it with all parts of the coast. It will, when completed, take the place of the present capital, Sapporo. According to Japanese maps, Mr. Landor's journey extended to 5000 miles, but his own reckoning puts it as 3800; almost the whole distance was done on horseback.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—By the death of Prof. Westwood on January 2 the University lost one of the most learned of its members, and another link with the earlier study of science in Oxford is gone. Prof. Westwood became Hope Professor on the foundation of the chair by the Rev. F. W. Hope in 1861, and afterwards devoted his time to the perfecting of the collection which Mr. Hope bestowed on the University. The collection, which has received considerable additions from other sources, including the Burchell collection, Wallace's types, &c., has attained somewhat unmanageable proportions, and its present quarters are too small for its proper display. Whoever succeeds to the chair, it is to be hoped that suitable provision will be afforded to enable him to make the collection of more use to University studies than has hitherto been the case.

In November last an examination for a Radcliffe Travelling Fellowship, thrown open, *pro hac vice*, to all branches of natural science, was held, but the result has not yet been announced. It is now announced that an examination will be held during this term for a second Radcliffe Fellowship, the subjects being strictly medical. It is believed that the results of the two examinations will be published together at the end of this term. There is some dissatisfaction at the delay in announcing the result of the first examination.

Prof. Ray Lankester has recovered from the illness which necessitated his absence from Oxford last term, and has resumed his lectures on the Vertebrata and a senior course on the Arachnida.

The Mathematical Scholarships and Exhibitions have been awarded as follows:—

Senior Mathematical Scholar, R. C. Fowler, B.A., of New College.

Proxime Accessit, S. F. White, B.A., of Wadham College, to whom the Examiners have awarded Lady Herschell's book.

Junior Mathematical Scholar, C. B. Underhill, Balliol College.

Junior Mathematical Exhibition, J. F. McKean, Hertford College.

Proxime Accessit, W. C. Childs, Corpus Christi College.

The Duchess of Marlborough has bestowed on the Chemical Department the entire collection of chemical and electrical apparatus belonging to the late Duke. The collection, which includes two exceptionally fine spectroscopes, delicate balances, &c., has been brought to the Museum from Blenheim, and forms a valuable addition to the Chemical Laboratory.

Mr. E. L. Collis, of Keble, is President, and Mr. M. D. Hill, of New College, is Treasurer of the Junior Scientific Club this term, and Messrs. C. H. H. Walker, of University College, and T. H. Butler, of Corpus Christi, are respectively Chemical and Biological Secretaries. The first meeting is held on Wednesday, February 1, when Mr. J. E. Marsh exhibits some products of the electrical furnace, and Messrs. Finn and Fremantle read papers on East Africa and Hermaphroditism.

At a meeting of the Biological Club, on Saturday last, Mr. G. C. Bourne read a paper on the influence of the nucleus on the cell.

CAMBRIDGE.—The Senate have resolved to appoint a Demonstrator in Palæozoology in connection with the Geological Department. He will have no stipend from the University, but will be remunerated from the fees paid by students.

Dr. Allbutt, Regius Professor of Physic, Dr. A. MacAlister, Professor of Anatomy, and Dr. Donald MacAlister, University Lecturer in Medicine, have been appointed to represent the University at the Eleventh International Medical Congress to be held at Rome in September next.

Dr. W. H. Gaskell has been appointed a member of the Special Board for Medicine, and Mr. C. T. Heycock a member of the Special Board for Physics and Chemistry. Dr. Ransome, F.R.S., Honorary Fellow of Gonville and Caius College; Dr. Corfield, F.R.S, Professor of Hygiene and Public Health in University College, London; Dr. J. Lane Notter, Professor of Military Hygiene at Netley; and Dr. Thorne Thorne, F.R.S., Medical Officer to H.M. Local Government Board, have been appointed Examiners in State Medicine for the Diploma in Public Health during the current year.

Sir G. G. Stokes and Dr. Hobson have been elected Examiners for the Adams Memorial Prize to be awarded in 1895.

Mr. E. H. Acton, of St. John's, and Mr. T. H. Easterfield, of Clare, have been approved as Teachers of Chemistry with reference to the regulations for medical and surgical degrees.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 15, 1892.—"Experiments on the Action of Light on *Bacillus anthracis*." By Prof. Marshall Ward, F.R.S.

It is abundantly evinced by experiments that direct insolation in some way leads to the destruction of spores of *Bacillus anthracis*, and in so far the results merely confirm what had already been discovered by Downes and Blunt in 1877 and 1878.[1]

From the fact that an apparent retardation of the development of the colonies on plates exposed to light was observed several times under circumstances which suggested a direct inhibitory action of even ordinary daylight, the author went further into this particular question with results as startling as they are important, for if the explanation given of the phenomena observed in the following experiments turns out to be the correct one, we stand face to face with the fact that by far the most potent factor in the purification of the air and rivers of bacteria is the sunlight. The fact that direct sunlight is efficacious as a bactericide has been long suspected, but put forward very vaguely in most cases.

Starting from the observation that a test-tube, or small flask containing a few c.c. of Thames water with many hundreds of thousands of anthrax spores in it may be entirely rid of living spores by continued exposure daily for a few days to the light of the sun, and that even a few weeks of bright summer daylight—not direct insolation—reduces the number of spores capable of development on gelatine, it seemed worth while to try the effect of direct insolation on plate-cultures to see if the results could be got more quickly and definitely.[2]

Preliminary trials with gelatine plate-cultures at the end of the summer soon showed that precautions of several kinds were necessary. The direct exposure of an ordinary plate-culture to the full light of even a September or October sun, especially in the afternoon, usually leads at once to the running and liquefaction of the gelatine, and although the exposed plates eventually showed fewer anthrax colonies than similar plates not exposed, the matter was too complicated to give satisfactory results. Obviously one objection was that the spores might have begun to germinate, and the young colonies killed by the high temperatures.

Experiments made in October with gelatine plates wrapped in black paper, in which a figure—a square, cross, or letter—was cut, also led to results too indefinite for satisfaction, although it was clear in some cases that if the plates lay quite flat, the illuminated area was on the whole clear of colonies, while that part of the plate covered by the paper was full of colonies.

But another source of vexation arose. After the plates had been exposed to the sunlight for, say, six hours, it was necessary to put them in the incubator (20°–22° C. was the temperature used) for two days or so, to develop the colonies, and in many cases it was observed that by the time the colonies were sufficiently

[1] See p. 237 of "First Report to the Water Research Committee of the Royal Society" ("Roy. Soc. Proc." vol. 51, 1892) for the literature on this subject up to 1891.

[2] It appears that Buchner (*Centr. f. Bakt.* vol. xii. 1892) has already done this for typhoid, and finds the direct rays of the summer sun quite effective.

far advanced to show up clearly, liquefaction had extended so far as to render the figure blurred and doubtful.

Stencil plates of zinc were employed with, at first, equally uncertain results. The stencil plate was fixed to the bottom of the plate culture, outside, and every other part covered with blackened paper: the plate was then placed on a level surface, the stencil-covered face upward, and exposed to the direct sunlight. As before, the gelatine softened and in many cases ran, and the results were uncertain, though not altogether discouraging.

In November it was found that more definite results could be obtained, and the problem was at last solved.

Meanwhile it had already been found possible to obtain sun prints in the following way with agar plates. Ordinary agar was heated and allowed to cool to between 50° and 60° C., and was then richly infected with anthrax spores, and made into plates as usual. Such plates were then covered with a stencil plate on the lower face—the stencil plate being therefore separated from the infected agar only by the glass of the plate—and wrapped elsewhere closely in dull black paper, so that, on exposure to the sun only the cut-out figure or letter allowed the solar rays to reach the agar.

Such plates were then exposed to the direct rays of the October sun for from two to six hours; or they were placed on the

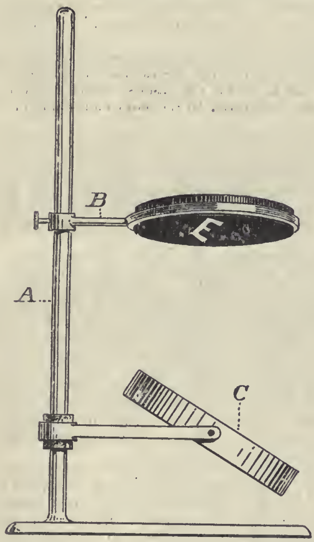


FIG. 1.

ring of a retort-stand, stencil downwards, and the sunlight reflected upwards from a plane mirror below.

After the insolation these plates were incubated for at least forty-eight hours at 20° C., and on removing the wrappers the colonies of anthrax were found densely covering all parts of the plate except the area—a letter or cross, &c.—exposed to the sunlight. There, however, the spores were killed, and the agar remained perfectly clear, showing the form of a sharp transparent letter, cross, &c., in a groundwork rendered cloudy and opaque by the innumerable colonies of anthrax.

Experiments proved that this was not due to high temperature, for a thermometer with its bulb next the insolated glass rarely rose beyond 14° to 16° C., and never beyond 18° C., and even if the thermometer did not record the temperature inside the plate, this can scarcely have been much higher.

As long as this latter point remained uncertain, however, the experiments could not be regarded as satisfactory; whence it was necessary to again have recourse to gelatine cultures. The gelatine employed began to run at 29° C., and in November it was found that such plates exposed outside, either to directly incident sunshine, or to directly reflected rays, showed a temperature of 12° to 13° C. at the insolated glass surface, and even five to six hours exposure caused no running of the gelatine.

The following experiment may be selected as a type of the rest:—A (Fig. 1) is the upright of an ordinary retort-stand; on the ring B rested a gelatine plate culture of anthrax spores, covered with black paper everywhere except the cut-out letter E, seen on its lower face. C was an ordinary plane microscope-mirror with its arm fitted to a cork on A.

The whole was placed in the middle of a field at 9.30 a.m. on Wednesday, November 30, and exposed to the clear, but low, sunshine which prevailed that day, the mirror being so arranged (from time to time as necessary) as to reflect the light on the E the whole period, until 3.30 p.m., when the plate was removed and placed in the dark incubator at 20° C. On the following Friday—*i.e.* after less than forty-eight hours' incubation—the letter E stood out sharp and clearly transparent from the faint grey of the rest of the plate of gelatine. Not a trace of anthrax could be found in the clear area, even with the microscope, while the grey and almost opaque appearance of the rest of the plate was due to innumerable colonies of that organism which had developed in the interval.

It was impossible to incubate the plate longer for fear of liquefaction, whence the sceptical may reply that the anthrax exposed to light was only retarded; the experiments with agar show that such is not the case, however, and that if the insolation is com-

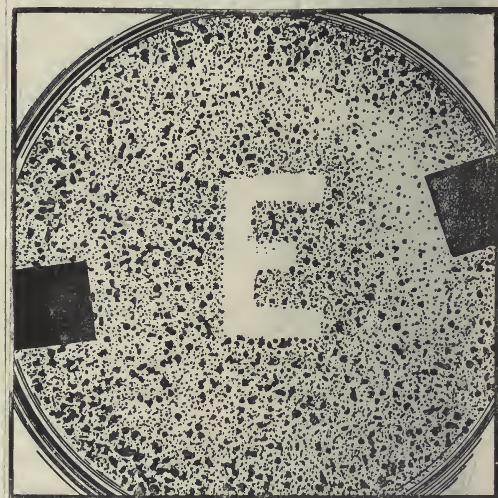


FIG. 2.

plete the spores are rendered incapable of germinating at all, as proved by removing pieces of the clear agar or gelatine and attempting to make tube cultures from them: in all cases where insolation is complete they remain sterile.

The chief value of these gelatine plate exposures in November, however, is that they prove conclusively (1) that the rays of a *winter* sun are capable, even if reflected, of killing the spores, and (2) that it is really the solar rays which do this directly, and not any effect of a higher temperature, since the gelatine remains solid throughout.

Experience has shown, however, that some precautions are necessary in selecting the anthrax cultures employed for these experiments with gelatine. The light certainly retards or kills (according to its intensity or the length of exposure) virulent spores, but if one takes the spores, mixed with vegetative bacilli, direct from a thoroughly liquefied gelatine culture, or from a bouillon culture, the plates are apt to be liquefied too rapidly for the proper development of the light print, evidently because so much of the liquefying enzyme is carried in when inoculating the plates. The same danger is run when active bacilli alone are employed.

The best method of avoiding these disadvantages has been

found to be the following, and it has the additional merit of enabling us to prove, beyond all doubt, that the ripe spores of *Bacillus anthracis* are really inhibited or killed by sunlight.

A few c.c. of sterile distilled water in a tube are thoroughly saturated with the anthrax spores taken from an old culture which has never been exposed to light, and the tube placed for twenty-four hours at 56° C.; this kills all immature spores, bacilli, and enzymes, and leaves us with a crop of the most resistant and fully matured virulent spores.

Experiments with such spores have been made to determine the relative power of the different rays of the spectrum to destroy the anthrax.

It is necessary to note first, however, that in experimenting with the electric light, although but few exposures have been made as yet, it is evident that its effects are feebler than those of the winter sun.

At present it has only been possible to observe that the inhibiting effects are stronger at the blue end of the spectrum than at the red, and exposures to sunlight passing through coloured glasses confirm this result; but the observations are being continued in the hope of getting a perfectly sharp record of the effects of each set of rays.

The following series of experiments are quoted in detail, because they teach several details of importance, in addition to proving the main fact.

On December 7 three gelatine plates and five agar plates were prepared with spores from a very vigorous and virulent agar tube of anthrax. The spores, which were quite mature, were not subjected to heat, but simply shaken in sterile water to wash and separate them thoroughly.

The three gelatine plates were made at 35° C., the agar plates at 60° C., neither of which temperatures could injure the ripe spores.

The three gelatine plates were labelled *p* 1, *p* 2, and *p* 3, and the agar plates *p* 4 to *p* 8 in order.

Immediately after making the plates, all were exposed to the December sun, except plates *p* 4, *p* 5, and *p* 6, and this was done as follows:—In each case the plate had a stencil plate with a cut-out letter on its lower face, and arranged as described above.

p 1, a gelatine plate with a *large* letter M, was exposed, face down, to the light reflected from a mirror (see Fig. 1) for three hours on December 7, and for four hours on December 8, the interval being passed in a cold room (*t* about 8°–9° C.), and then incubated at 20° in the dark.

p 8 was treated in exactly the same manner. But this was an agar plate with a *large* W.

p 2, a gelatine plate with a *large* H, was exposed and heated in the same way, except that no mirror was used, the latter being upwards towards the sun.

p 3, a gelatine plate with a *large* B, was similarly exposed, face up, but a plane mirror arranged to reflect light down upon it.

p 7, an agar plate with a *large* E, was treated exactly as the last.

There now remain the three agar plates, *p* 4, *p* 5, and *p* 6, to account for.

p 4 was placed forthwith in the dark incubator at 20° C.

p 5 and *p* 6 were kept for eighteen hours in a drawer, the average temperature of which is almost 16° C., and were not exposed till next day (December 8), when they lay for five hours, face upwards, and with a mirror above them. *p* 5 had a *small* E, and *p* 6 a broad but small I to let the light in.

After exposure, these also were put in the same incubator with the others.

Nothing was visible to the unaided eye on these plates (except *p* 4) until the 11th instant, though the microscope showed that germination was proceeding on the 10th. The plate *p* 4, however, had a distinct veil of colonies all over it on the 9th, and this had developed to a dense typical growth by the 11th.

On December 11, at 10 a.m., the state of affairs, as regards the exposed plates, was as follows:—

p 5 and *p* 6 showed each a sharp transparent letter—E and I respectively—of clear agar in a dull grey matrix of strong anthrax colonies, which covered all the unexposed parts of the plate.

p 1, *p* 2, and *p* 3 showed in each case a perfectly clear central patch, about 1½ inches diameter, with anthrax colonies in the gelatine around. These anthrax colonies were the *larger and more vigorous the more distant they were from the clear centre.* In other words, the anthrax spores had begun to germinate, and the colonies were growing more vigorously, in centripetal order.

On *p* 7 and *p* 8 germination was beginning, but the colonies were as yet too young to enable one to judge of the results.

The first point of interest is to account for the pronounced results in the plates *p* 5 and *p* 6, and the want of sharp outlines in *p* 1, *p* 2, and *p* 3, and the explanation seems to be that, owing to the plates 5 and 6 having laid over night at 16° C., the spores began slowly to germinate out, *and were consequently in their most tender condition* when exposed to the sunlight next day.

The peculiar centripetal order of development of the colonies on plates *p* 1, *p* 2, and *p* 3 gave rise to the following attempt at explanation. After observing that the clear space in the middle was not due to the centre of the plate being raised, and the infected gelatine having run down to the periphery—a possible event with some batches of Petrie's dishes—it was surmised that the *large* letters employed might give the clue.

This was found to be the case. The solar rays on entering the plate were largely reflected from the glass lid of the plates, and so produced feebler insolation effects on parts of the plate around the letter; these effects were naturally feebler and feebler towards the margin, and so the inhibitory action became less pronounced at distances further and further removed from the centre. Those spores, therefore, which were nearest the periphery germinated out first, and those nearer the centre were retarded and more and more in proportion to their proximity to the insolated letter.

That this is the correct interpretation of the facts follows clearly from the further behaviour of the above plates.

At 10 p.m. on the 11th—*i.e.* twelve hours after the morning examination—the plates *p* 1, *p* 2, and *p* 3 exhibited their respective letters M, H, and B quite clearly, in the grey matrix of anthrax which had rapidly developed in the interval, and excepting a slight want of sharpness in the H of *p* 2, the results could hardly have been more satisfactory.

In *p* 7 and *p* 8 the *very faint* outlines of the letters were also showing.

On the 12th, at 8.30 a.m., the gelatine plates had begun to run, and although the M of *p* 1 was still intact, and very well marked, *p* 2 had liquefied completely, so that the H was a clear patch with blurred outlines in the centre. *p* 3 still showed the outlines of the B, but it was impossible to keep it longer.

The main point was definitely established, however, and the treatment of the plates proves conclusively that the spores are not killed by high or low temperatures, *but by the direct solar rays.*

These experiments are being continued in order to answer some other questions in this connection.

The gelatine and agar after such exposures as have been described are still capable of supporting a growth of *B. anthracis* if fresh spores are sown on them, whence the effects described are not merely due to the sub-strata being spoilt as food material.

Royal Meteorological Society, January 18.—Dr. C. Theodore Williams, President, in the chair.—After the report had been read, and the officers and council for the ensuing year had been elected, the President delivered an address on the high altitudes of Colorado and their climates, which was illustrated by a number of lantern slides.—Dr. Williams first noticed the geography of the plateaux of these regions, culminating step by step in the heights of the rocky mountains, and described the lofty peaks, the great parks, the rugged and grand cañons, and the rolling prairie, dividing them into four classes of elevations between 5000 and 14,500 feet above sea level. He then dwelt on the meteorology of each of these divisions; giving the rainfall and relative humidity, and accounting for its very small percentage by the moisture being condensed on the mountain ranges of the Sierras lying to the west of the Rockies; also noticing the amount of sunshine and of cloudless weather, the maxima and minima temperatures, the wind force, and the barometric pressure. Dr. Williams quoted some striking examples of electrical phenomena witnessed on Pike's Peak (14,147 feet) by the observer of the U.S. Weather Bureau, when during a violent thunderstorm flashes of fire and loud reports, with heavy showers of sleet, surrounded the summit in all directions, and brilliant jets of flame of a rose-white colour jumped from point to point on the electric wire, while the cups of the anemometer, which were revolving rapidly, appeared as one solid ring of fire, from which issued a loud rushing and hissing sound. During another storm the

observer was lifted off his feet by the electric fluid, while the wristband of his woollen shirt, as soon as it became damp, formed a fiery ring around his arm. The climate of the Parks is, however, Dr. Williams considered, of more practical interest, and in these magnificent basins of park-like country interspersed with pines, and backed by gigantic mountains, are resorts replete with interest for the artist, the sportsman, the man of science, and the seeker for health. Most of them lie at heights of from 7000 to 9000 feet, and so good is the shelter that usually snow does not long remain on the ground, while Herefordshire cattle in excellent condition are able to fatten on the good herbage, and to lie out all the winter without shed or stable. Dr. Williams predicted for these parks a great future as high altitude sanitaria for the American continent, especially as several of them have been brought within easy distance of Denver, the queen city of the plains, by various lines of railway. The resorts on the foothills and on the prairie plains, at elevations of 5000 to 7000 feet, include, besides Denver, Colorado Springs, Manitou, Boulder, Golden, and other health stations, which can be inhabited all the year round, and where most of the comforts and luxuries of American civilisation are attainable in a climate where not more than half a day a week in winter is clouded over, where the rainfall is only about 14 inches annually, most of which falls during summer thunderstorms, where the sun shines brightly for 330 days each year, and where the air is so transparent that objects twenty miles off appear close at hand, and high peaks are calculated to be visible at a distance of 120 miles. Dr. Williams summed up thus:—The chief features of the climate of Colorado appear to be (1) Diminished barometric pressure, owing to altitude, which, throughout the greater part of the State, does not fall below 5000 feet. (2) Great atmospheric dryness, especially in winter and autumn, as shown by the small rainfall and low percentage of relative humidity. (3) Clearness of atmosphere and absence of fog or cloud. (4) Abundant sunshine all the year round, but especially in winter and autumn. (5) Marked diathermancy of atmosphere, producing an increase in the difference of sun and shade temperatures, varying with the elevation in the proportion of 1° for every rise of 235 feet. (6) Considerable air movement, even in the middle of summer, which promotes evaporation and tempers the solar heat. (7) The presence of a large amount of atmospheric electricity. Thus the climate of this state is dry and sunny, with bracing and energising qualities, permitting outdoor exercise all the year round, the favourable results of which may be seen in the large number of former consumptives whom it has rescued from the life of invalidism and converted into healthy active workers; and its stimulating and exhilarating influence may also be traced in the wonderful enterprise and unceasing labour which the Colorado people have shown in developing the riches, agricultural and mineral, of their country.

Entomological Society, January 18.—Sixtieth Annual Meeting.—Mr. Frederick DuCane Godman, F.R.S., President, in the chair.—An abstract of the treasurer's accounts having been read by Mr. J. Jenner Weir, one of the auditors, the secretary, Mr. H. Goss, read the report of the Council. After the ballot it was announced that the following gentlemen had been elected as officers and Council for 1893:—President, Mr. Henry J. Elwes; Treasurer, Mr. R. McLachlan, F.R.S.; Secretaries, Mr. Herbert Goss and the Rev. Canon Fowler; Librarian, Mr. George C. Champion; and as other members of the Council, Mr. C. G. Barrett, Mr. Charles J. Gahan, Mr. F. DuCane Godman, F.R.S., Mr. Frederic Merrifield, Mr. Osbert Salvin, F.R.S., Dr. David Sharp, F.R.S., Colonel Charles Swinhoe, and Mr. George H. Verrall. The President then delivered an address which, though containing reference to the Society's internal affairs and an allusion to the successful resistance made by naturalists and others to the War Office scheme for establishing a rifle-range in the New Forest, consisted for the most part of full obituary notices of Fellows of the Society who had died during the year, special mention being made of Mr. Henry W. Bates, F.R.S., Prof. Hermann C. C. Burmeister, Dr. Carl A. Döhrn, Mr. H. Berkeley-James, Mr. J. T. Harris, Sir Richard Owen, K.C.B., F.R.S., Mr. Henry T. Stainton, F.R.S., Mr. Howard Vaughan, and Prof. J. O. Westwood, the Hon. Life President. Votes of thanks to the President and other officers of the Society having been proposed by Lord Walsingham, F.R.S., and Dr. D. Sharp, F.R.S., and seconded by Mr. J. H. Leech and Mr. W. H. B. Fletcher, Mr. Godman, Mr. McLachlan, Mr. H. Goss, and Canon Fowler severally replied, and the proceedings terminated.

Linnean Society, January 19.—General Meeting, Prof. Charles Stewart, President, in the chair.—After the confirmation of the minutes the President referred in suitable terms to the losses sustained by biologic science in the deaths of Sir Richard Owen and Prof. J. O. Westwood, who had been Fellows of the Society for 56 and 64 years respectively.—Mr. George Brook showed photographs of corals which he had lately taken and had reproduced by permanent process at a cost below lithography, with the added advantage of permitting amplification by a hand lens.—The President read a paper on the auditory organ of the angel fish (*Rhina squatina*).—Mr. W. Carruthers, F.R.S., V.P.L.S., then laid before the Society the results of a collection made by Mr. Alexander Whyte in the Malanji country, in the Shiré highlands, in October, 1891, and the plants were determined by the officers of the Botanical Department, British Museum, about sixty, or, roughly speaking, one-fifth, proving new to science. Whilst Sir J. D. Hooker defined the flora of Kilimanjaro as Abyssinian in character, the Malanji flora displays a much closer relationship to the Cape.—The last paper was by Mr. G. F. Scott Elliot, and was his report as botanist to the Anglo-French Sierra Leone Boundary Commission, in which he gave an account of the economic aspects of the districts traversed.

Geological Society, January 11.—W. H. Hudleston, F.R.S., President, in the chair.—The following communications were read:—Variolite of the Lleyn, and associated volcanic rocks, by Catherine A. Raisin, B.Sc. Communicated by Prof. T. G. Bonney, F.R.S. The district in which these rocks occur is the south-western part of the Lleyn peninsula, marked on the Geological Survey map as "metamorphosed Cambrian." Some of the holocrystalline rocks are probably later intrusions. The igneous rocks, which are described in detail in the present paper, belong to the class of rather basic andesites or not very basic basalts; they show two extreme types, which were probably formed by differentiation from an originally homogeneous magma. Corresponding to the two types of rock are two forms of variolite. These are fully described, and their mode of development is discussed. The variolites occur near Aberdaron, and at places along the coast. Their spherulitic structure often is developed towards the exterior of contraction-spheriods, and in this and in other particulars they correspond with those of the Fichtelgebirge and of the Durance. The volcanic rocks include lava-flows and fragmental masses, both fine ash and coarse agglomerate. They are associated with limestones, quartzose, and other rocks, which are possibly sedimentary, but which give no trustworthy evidence of the age of the variolites. Prof. Judd complimented the authoress on the evidently great amount of labour and patient research devoted to this investigation. He thought the occurrence of the spherulitic structure round the surfaces of "pillow-like masses," similar to those described by Prof. Dana, was exceedingly interesting, especially when one considered the probably very great antiquity of these Caernarvonshire rocks. He thought, also, the suggestion that early crystallised magnetite-grains had formed the nuclei of the spherulites, was a very interesting and probable one. Mr. Alfred Harker, Profs. Bonney, Hull, and J. F. Blake also spoke.—On the petrography of the island of Capraja, by Hamilton Emmons. Communicated by Sir Archibald Geikie, For. Sec. R.S. The rocks of Capraja consist generally of andesitic outflows resting on andesitic breccias and conglomerates. The southern end seems to have formed a distinct centre of volcanic activity, whose products are younger in age and more basic in character than the rocks of the rest of the island, and may be termed "anamesites." The lavas appear to have flowed from a vent at some distance from the cone, which probably occurred here, and gave out highly scoriaceous fragments. In the other parts of the island andesite is almost everywhere formed, with patches of the underlying breccias here and there in the valley bottoms. The chief centre of activity probably lay west of the centre of the island. Petrographical details of the andesites and anamesites, descriptions of the groundmass and included minerals of each, and chemical analyses are given. As regards the age of the constituents, the author arranges them in the following order, commencing with the oldest:—Magnetite, olivine, augite, mica, felspar, nepheline. After the reading of this paper Dr. Du Riche Preller gave an outline of the leading geological and the

analogous petrological features of the several islands of the Tuscan Archipelago, of Corsica, Sardinia, the Carrara mountains, and the Maremma hills. The President also spoke.

Zoological Society, January 17.—Sir W. H. Flower, F.R.S., President, in the chair.—The Secretary read a report on the additions that had been made to the society's menagerie during the month of December, 1892.—Mr. F. C. Selous exhibited and made remarks on the head of a hybrid antelope between the Sassaby (*Bubalis lunata*) and Hartebeest (*B. caama*); also a head of a female Koodoo (*Strepsiceros kudu*) with horns, and heads of some other South African antelopes.—Mr. O. Thomas exhibited some examples (from the Baram River, Sarawak, collected by Mr. Hose) of the monkey that he had lately described as *Semnopithecus cruciger*, and stated that, in spite of the confirmation afforded by these specimens, Mr. Hose thought that this species might possibly be only an erythrism of *S. chrysomelas*.—A communication was read from Mr. E. Y. Watson, entitled, "A proposed classification of the *Hesperiidæ*, with a revision of the Genera." This contained a preliminary classification of the *Hesperiidæ*, including the numerous modern genera, which were arranged under three subfamilies according to the sexual differences, the resting posture, the antennæ, the spurs on the hind tibiæ, and the position of vein 5 (relative to veins 4 and 6) of the fore wing. The subfamilies were named Pyrrhopyginæ, Hesperiinæ, and Pamphilinæ, and the two last were subdivided into sections without names. In all 234 generic names were dealt with, of which 49 were treated as synonyms, while 45 new genera were described. Complete diagnoses were given of all the admitted genera.—A communication was read by Mr. E. E. Austen, entitled "Descriptions of New Species of Dipterous Insects of the Family *Syrphidæ*, in the Collection of the British Museum, with Notes on Species described by the late Francis Walker." This communication contained descriptions of twenty-three new species belonging to the division *Bacchini*, and of one belonging to the *Brachyopini* (genus *Rhingia*). An attempt was made to divide the genus *Baccha*, as at present existing, into three groups, based chiefly upon the shape and markings of the abdomen. The true position of the remarkable genus *Lycastrirhyncha*, founded by Bigot on a species from Brazil, and afterwards cancelled by its author in favour of *Rhingia*, was established. It was shown that this genus had nothing to do with *Rhingia*, but was one of the *Eristalini*, closely allied to *Eristalis*. It was also shown that the genus *Lycastris*, founded by Walker for a species from India, was not identical with *Rhingia* (as had been likewise suggested by Bigot), but belonged to the *Xylotini*, and was allied to *Criorrhina*. A communication was read from Mr. Gilbert C. Bourne, containing descriptions of two new species of Copepodous Crustaceans from Zanzibar, proposed to be called *Canthocamptus finni* and *Cyclops africanus*.—Mr. Sclater exhibited and made remarks on the typical specimen of a rare Argentine bird (*Xenopsaris albinucha*) described by the late Dr. Burmeister in 1868.

Anthropological Institute, January 24.—Anniversary meeting.—Dr. Edward B. Tylor, F.R.S., in the chair.—The following were elected officers and council for the ensuing year:—President, Prof. A. Macalister. Vice-Presidents, J. G. Garson, Chas. H. Read, F. W. Rudler. Secretary, C. Peek. Treasurer, A. L. Lewis. Council: G. M. Atkinson, Henry Balfour, E. W. Brabrooke, Hyde Clarke, J. F. Collingwood, Prof. D. J. Cunningham, W. L. Distant, J. Edge Partington, A. J. Evans, H. Gosselan, Prof. A. C. Haddon, T. V. Holmes, R. Biddulph Martin, R. Munro, F. G. H. Price, Oldfield Thomas, Arthur Thomson, Coutts Trotter, M. J. Walhouse, Gen. Sir C. P. Beauchamp Walker.

Edinburgh.

Royal Society, January 16.—Prof. Copeland, Vice-President, in the chair.—A paper, by Dr. W. Pole, on the present state of knowledge and opinion in regard to colour blindness, was communicated. He discussed alone the red-green form of colour blindness. In such a case the solar spectrum presents only two hues separated by a nearly colourless portion—a mixture of blue and yellow lights giving rise to a gray colour. According to Young the three primary colour sensations correspond to red, green, and blue or violet, and Maxwell and Helmholtz, reasoning on this theory, conclude that the colours seen in dichromic vision are green and blue. According to Dr. Pole, they are yellow and blue. He asserts that comparisons between normal and abnormal visions show that in general matches of colours made by a normal eye are also matches when regarded by a dichromic eye. He concludes that the two dichromic colours are colours known in normal vision. He then gives reasons for the conclusion that these colours are normal blue and yellow. In answer to the suggestion that the real subjective impressions may differ from what they are supposed to be, he says that the correspondence is proved by a large amount of evidence obtained by comparison with normal phenomena. He thinks that the following conclusions may be drawn from the second edition of Helmholtz's work on optics:—(1) The original mode of explanation of colour blindness by Young's theory is essentially withdrawn as no longer consistent with modern knowledge. The universal concurrent testimony, that the ordinary colour dichromic vision generally corresponds with is normal yellow and blue and white, is no longer disputed, and although there are variations of sensations in regard to red and green, the old ideas of blindness to red and green as separate and contrasting defects are abandoned; (2) that Young's general theory of three fundamental colour-sensations is still adhered to, but that the colours are now believed to differ considerably in the spectrum; (3) that dichromic vision might exist consistently with the retention of three fundamentals; (4) that the most prevalent form of dichromatism might be explained by the junction of the red and green fundamentals forming yellow. In conclusion, he regretted that the colour-vision committee of the Royal Society, in a recent chart dealing with colour blindness, had adhered to the old view held by Clerk Maxwell. Sir George Stokes remarked that the fundamental part of Young's original theory was that there were three colour sensations; and though he supposed them to be red, green, and violet, that was not essential. Maxwell only chose red, green, and blue, as representative sensations. He was doubtful of the wisdom of publishing the charts alluded to lest it might lead to misconception. The object of publishing them was to give to the public a general idea of the conclusions derivable from the trichromic theory.

Sydney.

Royal Society of New South Wales, December 7, 1892.—Prof. Warren, President, in the chair.—The Chairman announced that the Clarke Medal for 1893 had been awarded by the Council to Prof. Ralph Tate, of the Adelaide University.—A letter was read from the Hon. Ralph Abercromby, enclosing a cheque for £100, which he desired to place in the hands of the Council of the Society with the object of bringing about an exhaustive study of certain features of the Australian weather, the particulars to be furnished in a later letter. The following papers were read:—Observations on shell heaps and shell beds, the significance and importance of the record they afford, by E. J. Statham.—A new mineral from Broken Hill, by C. W. Marsh (communicated by Prof. Liversidge).—Notes on some Australian stone weapons, by Prof. Liversidge, F.R.S.—Notes on the recent cholera epidemic in Germany, by Dr. Schwarzbach.—Results of observations of Wolf's comet II., 1891, Swift's comet I., 1892, and Winnecke's periodical comet, 1892, at Windsor, New South Wales, by John Tebbutt.—On the comet in the constellation Andromeda, by John Tebbutt.—Languages of Oceania, by Dr. John Fraser.

August 17.—*Engineering Section*.—C. W. Darley in the chair.—Papers read:—Various systems of tramway traction, by W. F. How.——November 16.—Some notes on the economical use of steam, by T. H. Houghton.—Recent bridge building in New Zealand, by A. Alabaster.

Paris.

Academy of Sciences, January 23.—M. Lœwy in the chair.—Note on Nicolas de Kokcharow, by M. Daubrée.—Contributions to the study of the function of camphoric acid, by M. A. Haller.—On the pepto-saccharifiant action of the blood and the organs, by M. R. Lépine. If blood is poured into several parts of water at 56° C. a considerable quantity of sugar is formed in a few seconds, and the formation goes on for about an hour with decreasing rapidity. In cold or lukewarm water sugar is also produced, but its production is for the most part compensated by simultaneous glycolysis. It is also probable that the production of sugar is preceded by that of peptone. If an organ which does not enclose glycogen in any perceptible quantity be macerated for about an hour in three or four parts of water, the aqueous extract only contains a very small quantity

of substances capable of reducing Fehling's solution, and hardly any sugar. If to this aqueous extract be added a small quantity of peptone, and the whole be kept at 56°C. during an hour, a certain quantity of sugar is formed, as proved by fermentation and the phenylhydrazine test. Hence the aqueous or glycerine extract contains a ferment which may be termed pepto-saccharifiant. It is probable that the formation of sugar is not confined to the liver, as ordinarily supposed, but that several organs play a part in it.—Observations of the planet Charlois T (December 11, 1892), made at the Toulouse Observatory, by M. B. Baillaud.—Contribution to the investigation of the solar corona apart from total eclipses, by M. H. Deslandres (see Astronomical Column).—Observations of the sun made at the Lyon Observatory (Brunner equatorial) during the latter half of 1892, by M. Guillaume.—On the limitation of degree for the general algebraic integral of the differential equation of the first order, by M. Autonne.—On Van der Waals's equation and the demonstration of the theorem of the corresponding states, by M. G. Meslin.—Magnetic properties of bodies at different temperatures, by M. P. Curie.—The magnetic permeabilities of a series of diamagnetic bodies, including, amongst others, bismuth, antimony, phosphorus, sulphur, and some potassium salts, were determined by enclosing them in an exhausted glass vessel exposed to a magnetic field, and subsequently repeating the experiment with the glass alone. Most of the substances showed a remarkably constant coefficient. Water and quartz did not show a perceptible variation with temperature, and potassium nitrate had the same coefficient when solid and when fused. That of bismuth, on the other hand, fell steadily up to the point of fusion, and then (at 273° C.) abruptly from 0·957 to 0·038, after which it remained constant. Electrolytic antimony had a much feebler coefficient than the ordinary variety.—Contribution to the study of equalisers of potential acting by flow, by M. G. Gouré de Villemontée.—Luminous phenomena observed at the Lyon Observatory on the evening of January 6, 1893, by M. Gonnessiat.—A method for measuring objectively the spherical aberration of the living eye, by M. C. J. A. Leroy.—On the atomic weight of palladium, by MM. A. Joly and E. Leidié.—Action of the alkaline alcoholates on camphoric and other anhydrides, by M. P. Cazeneuve.—Modification of arterial pressure under the influence of pyocyanic poisons, by MM. Charrin and Teissier.—On some cases of infectious arthrodentary gingivitis observed in animals, by M. V. Galippe.—Primary bedding of platinum in the Ural, by M. A. Inostranzeff. The native platinum occurs embedded in a rocky matrix consisting of the variety of peridotite known as dunite. It is found in Mount Solovieff, which consists of alternate layers of chrome-iron and serpentine.—On the existence of overfolds in the Blida Atlas (Algeria), by M. E. Ficheur.

BERLIN.

Physical Society, January 6.—Prof. du Bois Reymond, President, in the chair.—Prof. Raoul Pictet gave an account of experiments made by Messrs. Sarasin and De la Rive by which the rate of the electric waves discovered by Hertz had been measured, and their identity with waves of light in the ether determined. By using large metallic surfaces sixteen metres in diameter as reflectors, and by allowing the discharge of the primary spark to take place under oil instead of in the air, it was found possible to obtain stationary electric waves in a long gallery and to determine their nodal points. In the discussion which ensued Prof. Kundt stated that Dr. Zenker was the first person who had explained the photographing of colours by means of stationary waves; that stationary light-waves were first experimentally determined by Dr. Wiener, and that Seebeck was the first to take photographs of coloured objects. After Prof. H. W. Vogel, pictures due to the action of light were first taken by a doctor named Schulz, in Halle. In 1727 this observer treated a solution of nitrate of silver in a small box with calcium chloride and obtained a greyish precipitate. He then covered the box with a lid in which was a hole the shape of some letter, and on subsequently examining the precipitate he saw a dark image of the letter on it. The experiment was found to fail in the dark. Schulz hence concluded that the image of the letter was due to the action of light.

Meteorological Society, January 10.—Prof. Schwalbe, President, in the chair.—Dr. Kremser spoke on the imperfection of the means available for the study of atmospheric currents, which, even in the most elevated stations, are profoundly modified by the topography of the neighbourhood. The direction and rate of these currents can only be ascertained by observing the motion of a small pilot-balloon of some one cubic metre capacity, a specially constructed theodolite being used for this purpose.—Prof. Hellmann exhibited a series of photographs of snow-crystals taken by Dr. Neuhauss, together with the oldest existing figures of these crystals, due to Olaus Magnus in 1455. The chief points of interest shown by these photographs were the not infrequent asymmetry of the crystals and the occurrence on them of small ice-lumps.

Physiological Society, January 13.—Prof. du Bois Reymond, President, in the chair. Dr. Behring gave an account of the present state of affairs as regards what may be called the blood-serum therapeutists, illustrating his remarks by experiments he had made with serum from an immune horse on mice inoculated with tetanus-bacilli. A number of mice were inoculated with more or less strong doses of the bacilli. Those which had previously been treated with the horse-serum did not die, and in many cases where the serum was injected after the inoculation death did not ensue. Observations on man are in progress, and will be published as soon as sufficient data are to hand on the treatment of tetanus and diphtheria by the use of serum from immune animals.—Dr. Hahn, of St. Petersburg, gave an account of experiments made in conjunction with Profs. Pawlow and Nencki on the action of an Eck's fistula, and the conducting of blood from the portal vein directly into the inferior vena cava. Among the various results of the operation he stated that the output of urea was lessened and that of uric acid increased, a result which the experimenters attributed to a cessation in the conversion of carbamic acid into urea due to exclusion of the liver. They further found that carbamic acid produced symptoms similar to those exhibited by the animals on which they had operated.—Prof. Kossel and Dr. Raps exhibited an automatic mercurial pump for blood-gas analysis.

CONTENTS.

THURSDAY, FEBRUARY 9, 1893.

THE MILKY WAY.

The Milky Way from the North Pole to 10° *of South Declination, drawn at the Earl of Rosse's Observatory at Birr Castle.* By Otto Boeddicker. (London: Longmans, Green, and Co., 1892.)

DR. OTTO BOEDDICKER devoted the clear moonless nights for five years, from October 1884 to October 1889, to delineating the Milky Way as it appeared to his unaided eyes at Parsonstown, Ireland. His drawings were deposited in the library of the Royal Astronomical Society, and a note accompanying them was read at the meeting of the Society in November 1889. The work now before us consists of four excellent lithographic reproductions of these drawings, a brief introductory preface being added by Dr. Boeddicker.

The working maps for the drawings were taken from Argelander's "Uranometria Nova," the Milky Way being inserted by means of stump and lead pencil. This medium was found very unsuitable for photographic reproduction, and in preparing the lithographic stones for these charts photography was used for the stars, and the Milky Way was introduced by hand work. Mr. W. H. Wesley, the Assistant Secretary of the Royal Astronomical Society, is responsible for this latter portion of the work, and the results are a splendid testimony to his care and skill. Dr. Boeddicker is to be congratulated upon having secured the services of so excellent an artist.

Plate I. is a detailed drawing of the Section Cygnus-Scutum, Plate II. of the Section Cassiopeiæ, and Plate III. of the Section Aurigæ-Gemini-Monocerotis. In these plates an attempt has been made to represent accurately the appearance of the galaxy, all the differences of luminosity being represented as they actually appeared to Dr. Boeddicker. In Plate IV. a general view on a smaller scale of the whole Milky Way from the North Pole to 10° south declination is given, the contrast being deliberately exaggerated in order to bring out clearly all the details.

The area of the Milky Way indicated on these drawings is very much greater than that on any previously published representations, while for delicate details and faithful reproduction of contrast the plates are unapproached. In many respects Dr. Boeddicker's drawings are a new revelation, branches, wisps, and feelers being shown extending from the main body so as to include stars, clusters and nebulæ, and even whole constellations not previously recognized as connected with or forming part of the Milky Way. Polaris, γ Arietis, Prœsepe, the Pleiades, the Hyades, the great nebula in Andromeda, and nearly the whole of the constellation Orion, are thus joined to the galactic circle. Numerous bright patches, channels, rifts, and interlacing lines of luminous matter hitherto unsuspected are revealed by Dr. Boeddicker's long and patient work, and exponents of disc, spiral, and other theories as to the construction of the Milky Way will find considerable difficulty in accounting for the details shown.

It is very difficult to compare drawings of the Milky Way made by different observers without optical aid. There are such wide variations in unaided vision, so many peculiarities introduced by long and short sight, by astigmatism, by irradiation in the retina, and by other physical and physiological imperfections, that it may safely be asserted that no two persons get exactly the same naked-eye impression of such a vague object as the Milky Way. As no details are given about Dr. Boeddicker's eyes we are probably justified in inferring that they are practically normal, but we doubt whether any other observer, even with special training, could check or correct these charts with reasonable prospect of convincing the original artist of error in the representation of the Milky Way as it appeared to him. Individual peculiarities of sight are minimized by the use of slight optical aid, and two equally experienced observers would be more likely to agree in their delineations of the Milky Way if they used similar telescopes, of say 1-inch aperture, or even ordinary opera glasses. Dr. Boeddicker's appeal to other observers to "verify and correct" his work will probably bring him plenty of correspondence, but can scarcely lead to any important correction in his magnificent drawings.

Dr. Boeddicker considers that "the first step necessary towards the knowledge of the sidereal universe is a thorough acquaintance with the Milky Way as it appears to the naked eye," and hopes that by comparison and the superposition of naked-eye drawings on photographs "some knowledge of the structure of the Milky Way *in the line of sight* may be obtained." This idea is founded on the theory that there is a direct connection between the magnitudes of stars and their distances. Littrow's analysis of Argelander's catalogue of stars certainly seemed to justify belief in this connection, but recent work has entirely disproved the hypothesis. Measurements of the parallax of stars indubitably prove that some faint stars are near, while some of the brightest are at such distances as to have no appreciable parallax. Thus α Orionis, α Virginis, α Leonis, and α Cygni have no parallax, while the 5th magnitude star 61 Cygni has a parallax of between $0''.4$ and $0''.5$. Photographs of the Pleiades show that we have in that cluster stars differing by as much as 13 magnitudes at approximately the same distance from us. Russell's photograph of α Crucis plainly indicates a direct physical connection between that star and many stars of the 14th and 15th magnitudes which should, according to the theory, be nearly 1000 times more distant. Streaks of nebulæ connect α Cygni and γ Cygni with long lines and stars of about the 16th magnitude in Dr. Max Wolf's photographs of the Milky Way. From considerations of parallax observations of stars and from examination of photographs we are forced to conclude that there is no real connection between magnitude and distance, and that the differences of magnitude of stars are due to differences of size and physical condition. Stars differ enormously in light-giving power, and the actual light emitted by α Cygni must be nearly a million times greater than that from the faint stars directly connected with it and at practically the same distance from us. There is therefore very little chance of adding to our knowledge of the Milky Way "in the line of sight" by superposition of naked-eye drawings on photographs.

In his preface Dr. Boeddicker frequently speaks of

"nebulosity," "nebulous light," and "nebulous matter," when he means luminosity and luminous matter. In ante-spectroscopic days the terms nebula and cluster were used almost indiscriminately, a nebula being looked upon as simply an irresolvable cluster, and this error still survives in many astronomical text-books and compilations, but Dr. Boeddicker should have avoided it. When we consider that the majority of the stars in the cluster which we call the Milky Way are of the Sirian type, we see how misleading is the use of the terms nebulous light and nebulous matter. A. T.

THE THEORY OF SUBSTITUTIONS AND ITS APPLICATIONS TO ALGEBRA.

The Theory of Substitutions and its Applications to Algebra. By Dr. Eugen Netto. Translated by F. N. Cole, Ph.D. (Mich.: Ann Arbor, 1892.)

THE theory of substitutions abstractly considered is concerned with the enumeration and classification of the permutations of a set of n different letters $x_1, x_2, \ldots, x_n$. It is scarcely apparent at first sight that a far-reaching mathematical theory could be built on a basis so simple, still less that there should be any connection between this and the complicated question of the solution of algebraical equations by means of radicals. It may be worth while, in order to excite the interest of mathematical readers in the work before us, to mention one or two points in the Theory of Substitutions which will give an inkling of the nature of its connection with the interesting problem just mentioned.

The operation of replacing—say in any function $\phi(x_1, x_2, x_3)$—any permutation of the letters, say x_1, x_2, x_3, by any other, say x_1, x_3, x_2, is called a *substitution*. This operation is denoted explicitly by $\begin{pmatrix} x_1, x_2, x_3 \\ x_1, x_3, x_2 \end{pmatrix}$, or shortly by a single letter s. Thus $s\phi(x_1, x_2, x_3) = \phi(x_1, x_3, x_2)$; and again: If t denote the substitution $\begin{pmatrix} x_1, x_2, x_3 \\ x_3, x_2, x_1 \end{pmatrix}$, $t\phi(x_1, x_3, x_2) = \phi(x_3, x_1, x_2)$. We may indicate the successive application of the two substitutions s and t by multiplying the symbols st in the order of application: thus $st\phi(x_1, x_2, x_3) = \phi(x_3, x_1, x_2)$ and $ts\phi(x_1, x_2, x_3) = \phi(x_2, x_3, x_1)$. In particular, the repetition of the same substitution may be represented by powers of the symbol; thus $s^2\phi(x_1, x_2, x_3) = \phi(x_1, x_2, x_3)$. The identical substitution $\begin{pmatrix} x_1, x_2, x_3 \\ x_1, x_2, x_3 \end{pmatrix}$ is represented by unity. The total number of different substitutions of n letters is obviously $n!$; consequently, if we form the consecutive powers of any substitution we shall ultimately arrive at a power s^m which will be the identical substitution, m being some positive integer not exceeding $n!$: m is called the *order* and n the degree of the substitution.

If among the substitutions of any given degree we can select a set which have the property that the product of any two furnishes another substitution belonging to the set, we obtain what is called a *group of substitutions*. The whole of the $n!$ substitutions of n letters obviously form a group, and the identical substitution by itself forms a group. It is easy, however, to see that in general there are other groups among the substitutions of a given degree. Consider, for example, any rational function $\phi(x_1, x_2, \ldots, x_n)$ which is not wholly asymmetric: there must exist a set of substitutions each of which leaves the value of ϕ unaltered. A substitution which is the product of any number of these must also leave ϕ unaltered: hence the set in question forms a group. We have here a fundamental point in the theory of substitutions, viz., the existence of a group of substitutions and the correlation therewith of rational functions which are unaltered by all the substitutions of the group. The group is said to belong to all the functions which it leaves unaltered; and these functions are said to form a family which is characterized by the group. Thus the group of a wholly asymmetric function is the identical group consisting of the substitution [1]; the group of the wholly symmetric functions consists of the whole of the $n!$ substitutions of the n^{th} degree; the group of the alternating functions consists of all those substitutions which are equivalent to an even number of transpositions, and so on. It is obvious that every rational function determines a group of substitutions, and it may be shown that, conversely, for every group of substitutions we may construct an infinity of rational functions which are unaltered by the substitutions of the group. The significance of this correlation between a group and a family of functions depends on the following important theorem, which is due in substance to Lagrange. If ψ be a rational function which is unaltered by all the substitutions of the group of ϕ (in other words, if the group of ψ contain the group of ϕ) then ψ can be expressed as a rational function of ϕ, and the n elementary symmetric functions

$$C_1 = \Sigma x_1,\ C_2 = \Sigma x_1, x_2, \ldots, C_n = x_1, x_2 \ldots x_n.$$

A particular case of this is the theorem that if the groups of ψ and ϕ be identical, then each can be expressed as a rational function of the other, and of the elementary symmetric functions. A limiting case of this theorem is the familiar result that every rational symmetric function can be expressed as a rational function of the elementary symmetric functions. As a special example consider the the two wholly asymmetric functions $\psi = ax_1 + bx_2$, $\phi = a/x_1 + b/x_2$: these both belong to the identical group, since they are changed by every substitution of the letters x_1, x_2. Hence ψ can be rationally expressed as a function of ϕ, C_1, C_2. The actual expression is in fact

$$\psi = \{2(a-b)^2C_2 - (a^2+b^2)C_1^2 + (a+b)C_1C_2\phi\}\{-(a+b)C_1 + 2C_2\phi\}/(a-b)^2(C_1^2 - 4C_2).$$

The application of the theory of substitutions is limited in the first instance to rational functions. Its use in the theory of the solution of algebraical equations by means of radicals is based on the following important result in the theory of irrational functions. Any root of a solvable equation $f(x) = 0$ can be expressed as a rational integral function of certain elements $V_1, V_2, \ldots, V_1$, the coefficients of which are rational functions of the coefficients of $f(x)$ and of primitive roots of unity. The quantities $V_1, V_2, \ldots, V_n$ are on the one hand rational integral functions of the roots of $f(x) = 0$ and of primitive roots of unity, and on the other hand are determined by a series of equations

$$V_{\alpha}^{p_{\alpha}} = F_{\alpha}(V_{\alpha-1}, V_{\alpha-2}, \ldots, V_v),$$

where p_{α} is a prime number and F is a rational function of the $V-s$. For example, in the case of the cubic

$x^3 - C_1x^2 + C_2x - C_3 = 0$, if $\Delta = -27C_3^2 + 18C_1C_2C_3 - 4C_1^3C_3 - 4C_2^3 + C_1^2C_2^2$, $S = 2C_1^3 - 9C_1C_2 + 27C_3$, $T = 9C_3 - 3C_1C_2$, the relations in question are

$$V_3^2 = -27\Delta,\ V_2^3 = \tfrac{1}{2}(S + V_3),\ V_1^3 = \tfrac{1}{2}(S - V_3);$$
$$V_1 = x_1 + \omega^2 x_2 + \omega x_3,\ V_2 = x_1 + \omega x_2 + \omega^2 x_3,$$
$$V_3 = T + 3\omega(x_1^2x_3 + x_2^2x_1 + x_3^2x_2) + 3\omega^2(x_1^2x_2 + x_2^2x_3 + x_3^2x_1);$$
$$x_1 = \tfrac{1}{3}\{C_1 + V_1 + V_2\},\ x_2 = \tfrac{1}{3}\{C_1 + \omega V_1 + \omega^2 V_2\},$$
$$x_3 = \tfrac{1}{3}\{C_1 + \omega^2 V_1 + \omega V_2\}.$$

By means of this theorem and certain elementary principles of the theory of substitutions an elegant and simple demonstration can be given of Abel's theorem that the solution by radicals of the general equation of the n^{th} degree is impossible when $n > 4$: see § 217 of the work before us.

Although the theory of substitutions bears, as we have just shown, on some of the oldest and most interesting of the problems of algebra, it has been comparatively little studied, especially by English speaking mathematicians. Dr. Cole has therefore rendered us a service of great importance by translating one of the standard treatises on this subject. Of the three that were at his disposal we think that he has chosen the one most likely to be useful to a beginner. While Serret in his "Higher Algebra" and Jordan in his "Traité" treat the theory from an abstract and more general point of view, Dr. Netto constantly associates with the substitution the function on which it is supposed to operate. This gives a powerful concrete aid to the comprehension of the propositions of the abstract theory and also helps the student to grasp their application. The great danger in subjects of such generality is that the stream of theorems is apt to run off the mind of the learner without soaking in, like water off the proverbial duck's back.

Dr. Netto's book will be found to contain all the ordinary theorems regarding the classification of substitutions, *e.g.* the existence of groups, transitive and intransitive, primitive and non-primitive, simple and compound; the theory of the algebraic relations between the values of multiple-valued functions and between functions belonging to or included in the same family; and also a considerable number of theorems regarding special groups. The applications embrace the theory of resolvents in general and of the Galois resolvent in particular; the general theory of the solvability of equations by means of radicals; the theory of the group of an equation and a discussion of the criteria of solvability; besides special applications to the cyclotomic and Abelian equations, and to equations three roots of which are connected by a rational relation.

The translation has been admirably done, both from the linguistic and from the mathematical point of view. We found, it is true, here and there passages which were somewhat obscure; but in every case, on comparing with the original, we found the rendering to be absolutely faithful. Such obscurities therefore must be charged either to the author, or to the nature of the subject, or to the idiosyncrasy of the critic, and not to the translator. We congratulate Mr. Cole on the successful completion of his arduous task, and heartily recommend the result to every lover of the most ancient and the most beautiful of all the sciences.

G. CH.

THE BRAIN IN MUDFISHES.

Das Centralnervensystem von Protopterus annectens; *eine vergleichend Anatomische Studie.* Von Dr. Rudolf Burckhardt. (Berlin: R. Friedländer und Sohn, 1892.)

THE Mudfishes, Dipnoi, from many peculiarities in their structure, have attracted the especial attention of anatomists and zoologists. Important monographs on Lepidosiren have been written by Owen and Wiedersheim, whilst Huxley, Günther, and Beauregard have described the anatomy of Ceratodus. Serres, in 1863, made a contribution to the anatomy of the nervous system of Protopterus, Fulliquet in 1886, and Parker in 1888, have also added to our knowledge of its structure; and now Dr. Burckhardt has published a well-illustrated monograph on the central nervous system of *Protopterus annectens.* He had obtained an ample supply of this fish from Herr W. Jezler, a merchant whose business engagements had taken him to the neighbourhood of Bathurst, Senegambia. On more than one occasion Dr. Burckhardt had received living fish, so that he was able to study the microscopic anatomy by the use of the most recent technical methods, and has thus added materially to our knowledge of the brain of this animal.

The author found, in the anterior horn of grey matter of the spinal cord, remarkably large nerve-cells, which possessed both branching protoplasm processes and an axial-cylinder process. In the lateral and posterior horns nerve-cells somewhat smaller in size were seen. The medulla oblongata gave origin to nerves which he names hypoglossal, vagus, glosso-pharyngeal, acusticofacialis, and trigeminus. He also describes two slender nerves as abducens and trochlearis, so that the Dipnoi are not, as some have said, destitute of these nerves. The cerebellum formed the anterior boundary of the 4th ventricle. Large nerve-cells, corresponding to those of Purkinje in the mammalian brain, were not seen. The mid-brain was distinct, and gave origin to a root of the trigeminus, to the optic tract and to the oculo-motor nerve: grey matter containing nerve-cells was grouped around the aqueduct of Sylvius.

Whilst Protopterus corresponded closely with the lowest vetebrates in the regions of the mid and hind brains it presented striking peculiarities in the pineal region. The roof of the 3rd ventricle was complicated, and possessed a velum, which represented a middle choroid plexus; a conarium, and a structure like that which Edinger has named "Zirbelpolster." The epiphysis (*Zirbel*) was attached to the skull by the arachnoid membrane.

The fore brain was well developed, and divided into two hemispheres. He recognized in it a posterior ventral swelling, which, because it contained cells similar to those found in the dentate gyrus (*fascia dentata*) of the higher brains, he describes as a lobus hippocampi. He distinguished a fissure which separated the lobus olfactorius from the pallial part of the hemisphere, so that he harmonizes the fore brain in its fundamental divisions with the mammalian brain as described by Broca and Turner. He directs attention to an elevation ventrad of the lobus olfactorius, which he calls the lobus post-olfactorius. This lobe is also found in the brains of

Selachia and Amphibia, and apparently corresponds to the lobus olfactorius posterior described by His in the human embryo, which forms the anterior perforated spot in the adult human brain. As regards its structure the hemisphere possessed central grey matter containing nerve-cells which lay around the hemisphere ventricle; also a mass of grey matter which he calls corpus striatum; whilst in the more posterior part of the ventral region of the hemisphere were nerve-cells which represented a cortical layer. In the dorsal region of the hemisphere also cortical nerve-cells were found, which were arranged as an inner and an outer layer. The cells of the cortex gave origin to nerve fibres. A definite anterior commissure was present, the fibres of which passed on each side into the lobus hippocampi. Burckhardt, also, figures, as distinct from the anterior commissure, fibres which he regards as the corpus callosum of Osborn. The most important tract of nerve fibres was the basal bundle, which ascended from the spinal cord into the corpus striatum.

One of the most interesting chapters in Burckhardt's memoir is that in which he gives an account of the saccus endolymphaticus. Wiedersheim had described in 1876, in *Phyllodactylus europæus*, a sac with many branching diverticula, filled with otolith-sand and lying in relation to the choroid plexus of the 4th ventricle. Hasse had previously seen in Amphibia a similar structure which Coggi had investigated in the frog. Burckhardt has for the first time observed and figured it in Protopterus. The saccus communicated by a narrow neck with the sacculus and utriculus of the auditory vesicle, and with its diverticula overlaid the region of the 4th ventricle, and extended as far back as the 1st pair of spinal nerves.

The memoir contains a short chapter on the phyletic development of the brain of Protopterus. Starting with Selachia, he considers that one line of development has been through Protopterus to Ichthyophis, and thence to the Urodela and Anura; another through Ceratodus to Reptilia and Mammalia; whilst a third line is from the Selachia to the Ganoids and Bony Fishes.

OUR BOOK SHELF.

The Chemical Basis of the Animal Body. An Appendix to Foster's "Text-Book of Physiology" (fifth edition). By A. Sheridan Lea, M.A., D.Sc., F.R.S. (London: Macmillan and Co., 1892.)

LIKE its parent volume, this well-known appendix has grown in bulk considerably, so that it now constitutes a treatise (separately paged and indexed) on the chemical substances occurring in the body. It contains numerous references to the text of Foster's "Physiology," and so the two may be most profitably read together.

The plan pursued in the present edition is the same as in former editions; the chemistry of the body is described under the headings of the names of the chemical substances. This plan has its advantages. It for instance gives a completeness to the description of any particular substance, whereas the other plan of describing the facts of animal chemistry, under the headings of the tissues, organs, and functions involves a certain amount of repetition and the facts relating to any one group, such as the proteids and carbohydrates will be found distributed in different chapters. Dr. Sheridan Lea's plan has, however, the disadvantage that it destroys continuity. Many of the paragraphs are necessarily short, and one passes from one subject to another with a certain amount of abruptness. The style of the writing is, however, interesting and clear, so that this disadvantage is reduced to a minimum. The parts that treat the subject in a fuller style, such as those in which ferment action, the origin of urea in the economy, or the relation of hæmoglobin to bile pigment are discussed, are models of lucid writing.

The book opens with a description of the proteids and ferments, the most important of physiological substances, but those of which, from the chemical standpoint, we know least. The simpler materials found in the body or its excreta are treated next. This is the more chemical part of the book, and the author expresses his indebtedness to Dr. S. Ruhemann for assistance here. One doubts whether this part of the work will prove attractive to ordinary students. There is no question that all medical students should be educated up to it, but at present organic chemistry and structural formulæ are subjects they are inclined to fight shy of. The concluding chapters are again devoted to substances of which we have a physiological rather than a chemical knowledge, namely, the pigments.

The figures of crystals, which form a new feature in the present edition, have been taken from the works of Krukenberg, Kühne, and Funke. One cannot conclude this notice without alluding to the extensive references to literature that are given throughout. This will prove a most valuable assistance to all original workers, and to those more earnest students who desire to go deeper into the subject. The references are provided with a separate index. They are chiefly to German literature. The German leanings of the author are seen also in the spelling of sarkosin, kreatin, &c. The final *e* is always omitted in the names of the amido acids. It would be a good thing in the future if international uniformity in the names of chemical compounds were adopted. In the meantime it seems a pity that Dr. Lea has not seen fit to use the spellings recommended by the Chemical Society of London.

The author is to be congratulated on having brought his labours to a successful conclusion, and we can pay the present volume no better compliment than to say that it is well worthy of those that have preceded it.

W. D. H.

Chambers's Encyclopædia. New Edition. Vol. X. (London and Edinburgh: W. and R. Chambers, 1892.)

THE editor and publishers of the present work may be cordially congratulated on the fact that it has now been successfully completed. A better encyclopædia of like scope does not exist in our own or any other language. Nominally it is merely a new edition; but in reality, as the editor claims in the preface, it must be regarded as to all intents and purposes a new work. One of the chief difficulties in an undertaking of this kind is to secure that each subject shall have the degree of attention which properly belongs to it, no single subject or group of subjects being permitted to usurp space which ought to be otherwise occupied. The editor has grappled with this difficulty so effectually that few readers will have occasion to complain of any lack of proportion in the length of the various articles. Another striking merit of the work is that all important subjects have been entrusted to specialists, so that students may have full confidence in the accuracy of the information offered to them about matters in which they happen to be particularly interested. The space at the disposal of the writers was so limited that what they have to say is not, of course, exhaustive, but it is sound as far as it goes, and is generally presented with most praiseworthy simplicity and

clearness. The present volume falls in no respect below the level of those which have preceded it. Among the writers of scientific articles are Prof. James Geikie, who deals with the triassic system and with volcanoes; Prof. Knott, who expounds the principles of thermodynamics; Dr. R. W. Philip, who writes of tubercle; and Sir F. Bramwell, who has a paper on water-supply.

Arthur Young's Tour in Ireland (1776–79). Edited, with Introduction and Notes, by A. W. Hutton. Two vols. (London: G. Bell and Sons, 1892.)

THIS reprint will be of real service to all who study the evolution of economic conditions in Ireland, and much of it ought also to excite and maintain the interest of the general reader. Arthur Young, as every one knows, was a remarkably accurate observer of such things as travellers have opportunities of noting, and his book on Ireland is in its own way hardly less valuable than his more celebrated work on France. The work was first published in 1780, in the course of which two English editions and one Irish edition were issued. Since that time it has not until now been reprinted as a whole. Mr. Hutton has done his work as editor admirably, and a most useful bibliography has been prepared by Mr. J. P. Anderson.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Some Lake Basins in France.

A FEW weeks since M. Delabecque, Ingénieur des Ponts et Chaussées at Thonon, kindly presented me with a copy of a work issued under his superintendence and to a great extent executed by himself,[1] to which I should be glad to call the attention of students of physiography. M. Delabecque, commissioned by the French Government, has made a series of soundings of ten lakes in France, near the Alpine region, and this Atlas records the results of his work. Contour-lines, in most cases 5 metres apart, indicate the forms of the lake-basins; the use of varying tints in blue makes these more distinct. Chief among the lakes included is the Léman, in the survey of which, as only one shore is French territory, the Swiss engineers have cooperated. A copy of this on a reduced scale, and without colours, appeared in Prof. Forel's book, "Le Lac Léman" (see NATURE, Nov. 3, 1892). Next in importance come the lakes of Annecy and of Bourget; the remainder are situated either in the French Jura or on the margin of the outer limestone zone of the Alps, a little south of the Rhone.

Excluding the Lake of Geneva, which was noticed in the article just mentioned, these lakes are especially interesting for their bearing on the difficult problem of the origin of lake-basins. Except the Lac de Bourget, none of these can be said to lie in a great mountain valley, or on the probable track of a great glacier. If then their basins have been excavated by glaciers, we might fairly expect the Alps and Jura to be "spattered" with lakes, for no appeal can be made to exceptional circumstances: while if the contours of their beds present resemblances to those of the larger Alpine lakes, such as the Lake of Geneva, the same explanation ought to apply in the main to both groups.

Without a reproduction of the charts it is impossible to give more than a rough idea of the evidence which they afford, but the following statements may be helpful. As a general rule the lakes deepen as they broaden, the deepest water being commonly found in the widest part. If in the course of the lake the shores markedly approach so as to form a kind of "narrow," this corresponds with a submerged neck or "col," which separates the bed into two basins, rising perhaps 10 metres or more above their general level. Not seldom the bed of a lake consists of a linear series, three to six in number, of shallow basins, so that a contour line, drawn along the axis of the lake, undulates up and down with an "amplitude" of from perhaps 3 to 5 metres. A rather long, blunt-ended oval is the prevalent form of these lakes, but to this there are exceptions. So far as can be ascertained the contours of the land above the water-line are reproduced beneath it. For instance, under the steep slopes of the Mont du Chat the bed of the Lac de Bourget plunges abruptly down to a depth of over 120 m. (its greatest depth being about 145 m.).

Of the Jura lakes, the Lac de St. Point (848·95 m. above the sea) is rather more than 6 kilometres long, the general width being rather less than one-tenth of this; a considerable part of its floor is 30 to 35 metres deep, and its greatest depth is about 42 metres. It contains no less than 6 basins, parted by "cols" about half-a-dozen metres above their lowest parts. This lake is on the course of the Doubs, and lies parallel with the general strike of the Jura, *i.e.* from N.E. to S.W. The Lac de Brenets on the same river, nearly 100 metres lower down, is a narrow, winding lake, roughly 150 metres wide and perhaps 8 or 9 times as long. At its upper end is a sharply projecting, rather shallow bay, but the channel of the Doubs can be traced clearly through this, deepening gradually from 5 to nearly 27 metres and the whole lake is evidently only an enlargement of the river.

The subalpine lakes are no less interesting, and their testimony generally agrees with that summarised above. Want of space forbids us to mention more than the lake of Annecy. This is deepest (about 65 m.) in its northern and widest part (nearest to the effluent). The sub-aqueous contours on the western side are interrupted, to within about 10 metres from the bottom of the lake, by a prominence, just like a drowned hilly spur. The shallowest soundings over this, near its northern (outer) part, are only 3·3 metres, and the ground falls rapidly down from 5 to 55 metres. On its northern or "lee" side (assuming a glacier to have followed the course of the water) is a submerged valley over 40 metres deep. The Lake of Annecy exhibits another very singular feature. Near its northern end the bed deepens very rapidly from 30 to 80 metres; this funnel-shaped cavity is less than 200 metres in diameter, and is probably a submerged swallow hole. These notes may, it is hoped, suffice to indicate the importance of this work. The gratitude of students is due to M. Delabecque for supplying them with a valuable group of facts, the collection of which must have entailed great labour. These, however, appear to me not to lend themselves very readily to the support of the glacial excavation hypothesis; but to be more favourable to that which regards the larger Alpine lakes as mainly formed by movements of the earth's crust after the erosion of the valleys in which they lie.

T. G. BONNEY.

[1] "Atlas des Lacs Français, Ministère des Travaux Publics." No publisher's name appears on the sheets, but I am informed by M. Delabecque that the Atlas can be obtained at Georg's Library, Geneva.

Dust Photographs.

IN Mr. Croft's paper on "Breath Figures," printed in NATURE for December 22 of last year (pp. 187, 188) he states:—"Two cases have been reported to me where blinds with embossed letters have left a latent image on the window near which they lay." The statement is not quite clear as I do not understand whether the letters were in contact with the glass or not.

Perhaps it may be interesting to place on record an observation of my own, made a few years ago, which struck me at the time as curious, but which I have not been able to verify since.

At the stations of the District Railway there is a useful arrangement by which passengers are informed of the destination of the next train. It consists of a shallow box with glass sides into which by a mechanical contrivance boards are let down on which the names of the stations are painted in white letters on a blue ground. The board with the words 'INNER CIRCLE' is most frequently exposed. At night the box is (or was) illuminated obliquely on either side by a tolerably powerful lamp.

One night I was waiting for the train at the Victoria Station. There was some dislocation in the service; the destination of the next train was uncertain and the box was empty. On glancing at it somewhat sideways I was however astonished to see the words 'INNER CIRCLE' on the glass side of the box in quite clear dark letters on a pale illuminated ground. I drew the attention of one of the platform officials to it. He saw it with perfect distinctness, and seemed to think he had

noticed it before. Of course when the apparatus is in full working order there is little opportunity for doing so.

The only explanation I could think of was:—(i) that the light of the lamp had produced some molecular change in the paint coating the notice board; (ii) that this had affected differently the blue and the white paint; (iii) that the same cause had set up some differential electrical condition of the board and the glass; (iv) that a bombardment of particles of the blue paint had taken place on to the glass to which they had adhered; and that (v) the particles so adhering, by dispersing the light, produced the effect of the pale illuminated ground while the spaces occupied by the letters being relatively clean stood out dark.

Royal Gardens, Kew, W. T. THISELTON-DYER.
February 1.

MR. W. B. CROFT'S paper on Breath-Figures in your issue of December 22 reminded me of some curious impressions of monumental brasses which are to be seen on the walls of Canterbury Cathedral. When I saw these impressions a few years ago, it occurred to me that they might have been produced by mere contact, the brass plates having possibly been hung for many years against the walls, in secluded corners, at a time when the Reformers would not let them remain in their proper matrices on the church floor. I had forgotten the particulars of these figures, but Dr. Sheppard, of Canterbury, has kindly sent me the following notes by favour of Canon Fremantle:—"A number of impressions of brasses are in the basement (which is open to the air) under Henry IV.'s chantry in the Cathedral. A very good impression is on the western column of the crypt of Trinity Chapel. . . . On the walls appear the shapes of the effigies. Sometimes the stone is unstained all over the area of the figure, and surrounded by a broad dark smudge: and sometimes the case is reversed, and the figure is the exact negative of the former kind; that is to say, the area of the figure is indicated by an uniform dark tint, whilst the surrounding stone is unstained." Dr. Sheppard suggests "that an exact pattern seems to have been made in paper and then fixed to the wall whilst it was brushed over with linseed oil. But this does not account for the white effigies on a dark ground."

I would commend these impressions to the notice of those interested in the subject. It may be that, though some were made intentionally, others are the result of simple contact.

F. J. ALLEN.

Mason College, Birmingham, February 4.

Fossil Plants as Tests of Climate.

IN continuation of my recent letter, permit me to call attention to a communication on the bread fruit trees in North America, by Mr. F. H. Knowlton, of the National Museum, Washington, U.S., which appears in your American contemporary *Science* for January 13. The forty living species of *Artocarpus* are all confined to tropical Asia and the Malay Archipelago. *A. incisa*, the true bread fruit tree, and one or two others, are largely cultivated in the tropics. They are small or medium-sized trees with a milky juice, large leathery leaves, and monœcious flowers. The female flowers are long club-shaped spikes, which uniting form one large mass known as the "bread fruit," the interior containing a pulp when ripe like new bread.

The first fossil bread fruit was discovered in boulder county Colorado in late cretaceous rock, and was named by the late Prof. Leo Lesquereux *Myrica (?) Lessigiana*, other fragments he called *Aralia pungens*. The subsequent researches, or more perfect specimens of Dr. A. S. Nathorst, proved these to belong to one species, *Artocarpus Lessigiana*. Dr. Nathorst is the discoverer of another species closely allied to *A. incisa*, which he calls *A. Dicksoni*, which he obtained from the cretaceous flora of Waigatt, West Greenland, which the previous labours of Profs. Heer and Nordenskiöld had shown to be of a tropical or sub-tropical character, containing as it does numerous species of ferns of the order Gleichenialeæ, and several species of cycas.

CHAS. E. DE RANCE.

H.M. Geological Survey, Alderley Edge, Manchester.

Lunar Rainbow in the Highlands.

THIS interesting phenomenon (a very unusual one in this latitude) was observed near here on the morning of the 3rd inst., about six a.m. The moon was two days past full, and was not shining particularly brightly, being obscured, except at considerable intervals, by driving mist and light clouds. The bow, however, was exceedingly well marked, and formed a singularly beautiful object, stretching as it did completely across the north-western end of Loch Oich, glimmering against the dark background of the mountains, and sinking into the water on the southern shore of the loch. The general colour of the bow was yellow deepening into orange, several of the prismatic colours, however, being intermittently visible, especially a tinge of violet on the upper side.

O. S. B.

The Abbey, Fort-Augustus, N.B.

OPTICAL CONTINUITY.[1]

KEENNESS of sight is measured by the angular distance apart of two dots when they can only just be distinguished as two, and do not become confused together. It is usually reckoned that the normal eye is just able or just unable to distinguish points that lie one minute of a degree asunder. Now, one minute of a degree is the angle subtended by two points, separated by the 300th part of an inch, when they are viewed at the ordinary reading distance of one foot from the eye. If, then, a row of fine dots touching one another, each as small as a bead of one 300th part of an inch in diameter, be arranged on the page of a book, they would appear to the ordinary reader to be an extremely fine and continuous line. If the dots be replaced by short cross strokes, the line would look broader, but its apparent continuity would not be affected. It is impossible to draw any line that shall commend itself to the eye as possessing more regularity than the image of a succession of dots or cross strokes, 300 to the inch, when viewed at the distance of a foot. Every design, however delicate, that can be drawn with a line of uniform thickness by the best machine or the most consummate artist, admits of being mimicked by the coarsest chain, when it is viewed at such a distance that the angular length of each of its links shall not exceed one minute of a degree. One of the apparently smoothest outlines in nature is that of the horizon of the sea during ordinary weather, although it is formed by waves. The slopes of *débris* down the sides of distant mountains appear to sweep in beautifully smooth curves, but on reaching those mountains and climbing up the *débris*, the path may be exceedingly rough.

The members of an audience sit at such various distances from the lecture table and screen, that it is not possible to illustrate as well as is desirable, the stages through which a row of dots appears to run into a continuous line, as the angular distance between the dots is lessened. I have, however, hung up chains and rows of beads of various degrees of coarseness. Some of these will appear as pure lines to all the audience; others, whose coarseness of structure is obvious to those who sit nearest, will seem to be pure lines when viewed from the furthest seats.

Although 300 dots to the inch are required to give the idea of perfect continuity at the distance of one foot, it will shortly be seen that a much smaller number suffices to suggest it.

The cyclostyle, which is an instrument used for multiple writing, makes about 140 dots to the inch. The style has a minute spur wheel or roller, instead of a point; the writing is made on stencil paper, whose surface is covered with a brittle glaze. This is perforated by the teeth of the spur wheel wherever they press against it. The half perforated sheet is then laid on writing paper, and an inked roller is worked over the glaze. The ink passes through the perforations and soaks through them on to the paper below; consequently the impression consists entirely of short and irregular cross bars or dots.

[1] Extract from a lecture on "The Just-Perceptible Difference," delivered before the Royal Institution on Friday, January 27, by Francis Galton, F.R.S.

I exhibit on the screen a circular letter summoning a Committee, that was written by the cyclostyle. The writing seems beautifully regular when the circular is photographically reduced; when it is enlarged, the discontinuity of the strokes becomes conspicuous. Thus, I have enlarged the word *the* six times; the dots can then be easily seen and counted. There are 42 of them in the long stroke of the letter *h*.

The appearance of the work done by the cyclostyle would be greatly improved if a fault in its mechanism could be removed, which causes it to run with very unequal freedom in different directions. It leaves an ugly, jagged mark wherever the direction of a line changes suddenly.

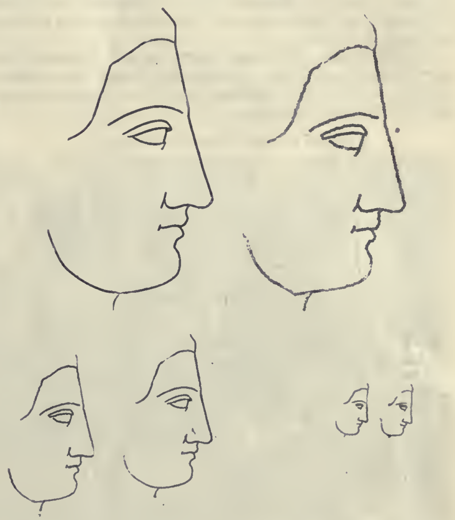
A much coarser representation of continuous lines is given by embroidery and tapestry, and coarser still by those obsolete school samplers which our ancestresses worked in their girlhood, with an average of about sixteen stitched dots to each letter. Perhaps the coarsest lettering that is ever practically employed is used in perforating the books of railway coupons so familiar to travellers. Ten or eleven holes are used for each figure.

A good test of the degree of approximation with which a cyclostyle making 140 perforations to the inch is able to simulate continuous lines, is to use it for drawing outline portraits. I asked the clerk who wrote the circular just exhibited to draw me a few profiles of different sizes, ranging from the smallest scale on which the cyclostyle could produce recognisable features, up to the scale at which it acted fairly well. Here are some specimens of the result. The largest is a portrait of $1\frac{1}{2}$ inches in height, by which facial characteristics are fairly well conveyed; somewhat better than by the rude prints that appear occasionally in the daily papers. It is formed by 366 dots. A medium size is $\frac{3}{4}$ inch high and contains 177 dots, and would be tolerable if it were not for the jagged strokes already spoken of. The smallest sizes are $\frac{1}{3}$ inch high and contain about ninety dots; they are barely passable, on account of the jagged flaws, even for the rudest portraiture.

I made experiments under fairer conditions than those of the cyclostyle, to learn how many dots, discs, or rings per inch were really needed to produce a satisfactory drawing, and also to discover how far the centres of the dots or discs might deviate from a strictly smooth curve without ceasing to produce the effect of a flowing line. It must be recollected that the eye can perceive nothing finer than a minute blurr of one three-hundredth part of an inch in angular diameter. If we represent a succession of such blurs by a chain of discs, it will be easily recognised that a small want of exactitude in the alignments of the successive discs must be unimportant. If one of them is pushed upwards a trifle and another downwards, so large a part of their respective areas still remain in line, that when the several discs become of only just perceptible magnitude, the projecting portion will be wholly invisible. When the discs are so large as to be plainly perceptible, the alignment has to be proportionately more exact. After a few trials it seemed that if the *bearing* of the centre of each disc from that of its predecessor which touched it, was correctly given to the nearest of the 16 principal points of the compass, N., NNE., NE., &c., it was fairly sufficient. Consequently a simple record of the successive bearings of each of a series of small equidistant steps is enough to define a curve.

The briefest way of writing down these bearings, is to assign a separate letter of the alphabet to each of them, *a* for north (the top of the paper counting as north), *b* for north-north-east, *c* for north-east, and so on in order up to *p*. This makes *e* represent east, *i* south, and *m* west.

To test the efficiency of the plan, I enlarged one of the cyclostyle profiles, and making a small protractor with a piece of tracing paper, rapidly laid down a series of equidistant points on the above principle, noting at the same time the bearing of each from its predecessor. I thereby obtained a formula for the profile, consisting of 271 letters. Then I put aside the drawing, and set to work to reproduce it solely from the formula. I exhibit the result; it is fairly successful. Emboldened by this first trial, I made a more ambitious attempt, by dealing with the profile of a Greek girl copied from a gem. I was very desirous of learning how far the pure outline of the original admitted of being mimicked in this rough way. The result is here; a ring has been painted round each



dot in order to make its position clearly seen, without obliterating it. The reproduction has been photographically reduced to various different sizes. That which contains only fifty dots to the inch, which is consequently six times as coarse as the theoretical 300 to an inch, is a very creditable production. Many persons to whom this portrait has been shown failed to notice the difference between it and an ordinary woodcut. The medium size, and much more the smallest size, would deceive anybody who viewed them at the distance of one foot. The protractor used in making them was a square card with a piece cut out of its middle, over which transparent tracing paper was pasted. A small hole of about $\frac{1}{8}$ of an inch in diameter was punched out of the centre of the tracing paper; sixteen minute holes just large enough to allow the entry of the sharp point of a hard lead-pencil were perforated through the tracing paper in a circle round the centre of the hole at a radius of $\frac{1}{4}$ inch. They corresponded to the 16 principal points of the compass, and had their appropriate letters written by their sides. The outline to be formulated was fixed to a drawing-board, with a T rule laid across it as a guide to the eye in keeping the protractor always parallel to itself. The centre of the small hole was then brought over the beginning of the outline, and a dot was made with the pencil through the perforation nearest to the further course of the outline, and this became the next point of departure. While moving the protractor from the old point to the new one it was stopped on the way, in order that the letter for the bearing might be written through the central hole.

A clear distinction must be made between the proposed plan and that of recording the angle made by each step from the *preceding one*. In the latter case, any error of

bearing would falsify the direction of all that followed, like a bend in a wire.

The difficulties of dealing with detached portions of the drawing, such as the eye, were easily surmounted by employing two of the spare letters, R and S, to indicate brackets, and other spare letters to indicate points of reference. The bearings included between an R and an S were taken to signify directive dots, not to be inked in. The points of reference indicated by other letters are those to which the previous bearing leads, and from which the next bearing departs. Here is the formula whence the *eye* was drawn. It includes a very small part of the profile of the brow, and the directive dots leading thence to the eye.

The letters should be read from the left to the right, across the vertical lines. They are broken into groups of five, merely for avoiding confusion and the convenience of after reference.

The part of the Profile that includes U

&c. iiiilU jiihi &c. &c.

The Eye.

URkkk mlmlm mmnZZ onooZ	kklll llmZZ Tjjjj	mSVap VnTnn jjkkc	ponmn mnmmm cbmmn	mmlmm mmmlm mnnnn

Letters used as Symbols.

R....S=(....). Z=end.
U, V, T are points of reference.

By succeeding in so severe a test case as this Greek outline, it may be justly inferred that rougher designs can be easily dealt with in the same way.

At first sight it may seem to be a silly waste of time and trouble to translate a drawing into a formula, and then, working backwards, to retranslate the formula into a reproduction of the original drawing, but further reflection shows that the process may be of much practical utility. Let us bear two facts in mind, the one is that a very large quantity of telegraphic information is daily published in the papers, anticipating the post by many days or weeks. The other is that pictorial illustrations of current events, of a rude kind, but acceptable to the reader, appear from time to time in the daily papers. We may be sure that the quantity of telegraphic intelligence will steadily increase, and that the art of newspaper illustration will improve, and be more resorted to. Important local events frequently occur in far-off regions, of which no description can give an exact idea without the help of pictorial illustration; some catastrophe, or site of a battle, or an exploration, or it may be some design or even some portrait. There is therefore reason to expect a demand for such drawings as these by telegraph, if their expense does not render it impracticable to have them. Let us then go into details of expense, on the basis of the present tariff from America to this country, of one shilling per word, 5 figures counting as one word, cypher letters not being sent at a corresponding rate. It requires two figures to perform each of the operations described above, which were performed by a single letter. So a formula for 5 dots would require 10 figures, which is the telegraphically equivalent of 2 words; therefore the cost for every 5 dots telegraphed from the United States would be 2 shillings, or £2 for every 100 dots or other indications.

In the Greek outline there is a total of 400 indications, including those for directive dots, and for points of reference. The transmission of these to us from the United States would cost £8. I exhibit a map of England made with 248 dots, as a specimen of the amount of work in plans, which could be effected at the cost of £5. It is easy to arrange counters into various patterns or parts of patterns, learning thereby the real power of the process. The expense of pictorial telegraphs to foreign countries would be large in itself, but not large relatively to the present great expenditure by newspapers on telegraphic information, so the process might be expected to be employed whenever it was of obvious utility.

The risk is small of errors of importance arising from mistakes in telegraphy. I inquired into the experience of the Meteorological Office, whose numerous weather telegrams are wholly conveyed by numerical signals. Of the 20,625 figures that were telegraphed this year to the office from continental stations, only 49 seem to have been erroneous, that is two and a third per thousand. At this rate the 800 figures needed to telegraph the Greek profile would have been liable to two mistakes. A mistake in a figure would have exactly the same effect on the outline as a rent in the paper on which a similar outline had been drawn, which had not been pasted together again with perfect precision. The dislocation thereby occasioned would never exceed the thickness of the outline.

The command of 100 figures from 0 to 99, instead of only 26 letters, puts 74 fresh signals at our disposal, which would enable us to use all the 32 points of the compass, instead of 16, and to deal with long lines and curves. I cannot enter into this now, nor into the control of the general accuracy of the picture by means of the distances between the points of triangles each formed by any three points of reference. Neither need I speak of better forms of protractor. There is one on the table by which the ghost of a compass card is thrown on the drawing. It is made of a doubly refracting image of Iceland spar, which throws the so-called "extraordinary" image of the compass card on to the ordinary image of the drawing and is easy to manipulate. All that I wish now to explain is that this particular application of the law of the just perceptible difference to optical continuity gives us a new power that has practical bearings.

POSTSCRIPT.—A promising method for practical purposes that I have tried, is to use "sectional" paper; that is, paper ruled into very small squares, or else coarse cloth, and either to make the drawing upon it, or else to lay transparent sectional paper, or muslin, over the drawing. Dots are to be made at distances not exceeding 3 spaces apart, along the course of the outline, at those intersections of the ruled lines (or threads) that best accord with the outline. Each dot in succession is to be considered as the *central point*, numbered **44** in the following schedule, and the couplet of figures corresponding

11	21	31	41	51	61	71
12	22	32	42	52	62	72
13	23	33	43	53	63	73
14	24	34	**44**	54	64	74
15	25	35	45	55	65	75
16	26	36	46	56	66	76
17	27	37	47	57	67	77

to the portion of the next dot, is to be written with a fine pointed pencil in the interval between the two dots. These are subsequently copied, and make the formula. By employing 4 for zero, the signs of + and − are avoided; 3, standing for −1, 2, for −2; and 1, for −3. The first figure in each couplet defines its horizontal coordinate from zero; the second figure, its vertical one. Thus any one of 49 different points are indicated, corresponding to steps from zero of 0, ±1, ±2, and ±3 intervals, in either direction, horizontal or vertical. Half-an-hour's practice suffices to learn the numbers. The figures 0, 8, and 9 do not enter into any of the couplets in the schedule, the remaining 51 couplets in the complete series of 100 (ranging from 00 to 99), contain 21 cases in which 0, 8, or 9 forms the first figure only; 21 cases in which one of them forms the

second figure only, and 9 cases in which both of the figures are formed by one or other of them. These latter are especially distinctive. This method has five merits—medium, short, or very short steps can be taken according to the character of the lineation at any point; there is no trouble about orientation; the bearings are defined without a protractor, the work can be easily revised, and the correctness of the records may be checked by comparing the sums of the small coordinates leading to a point of reference, with their total values as read off directly.

A method of signalling is also in use for military purposes, in which positions are fixed by coordinates, afterwards to be connected by lines. F. G.

BRITISH NEW GUINEA.[1]

MR. THOMSON'S work on British New Guinea has been looked for with some impatience. Now that it has come it falls short of our expectations. We had hoped for a comprehensive work marshalling into order and summarising the observations and investigations made in the British part of New Guinea, by so many missionaries, explorers, naval and government officers and scientific men, for many years. Instead of this we find that the book is made up almost entirely of the explorations during the past four or five years of the administrator, boiled down out of the official reports by Mr. J. Thomson, the secretary of the Queensland branch of the Geographical Society of Australasia. Throughout the volume there is everywhere evidence that its author is new to literary composition. In consequence, the terse and vigorous English of the original reports suffers severely in the process, so much so that we regret that their important parts have not been presented to us as extracts in the explorer's own words. Mr. Thomson has himself never visited New Guinea, if we may judge by internal evidence, although his phraseology in many places is not unlikely to lead the reader to suppose that he has had a share in the results presented in its pages. Had the author had some personal acquaintance with the country of which he writes he would have formed opinions, we believe, different from many of those he has expressed on his own account throughout the book.

The work opens with a sketch "of the historical aspects of the whole of the great Papuan land," but we miss in it the names of many who deserve honourable mention for their contributions to the "making" of New Guinea. We find no mention of the investigations of Dr. Otto Finsch carried on in all three possessions, of those of Mr. O. Stone, of the missionaries in Geelvink Bay, of Mr. Romilly, of the Special Commissioners Sir Peter Scratchley and the Hon. John Douglas, of Mr. Milman, and of Commanders Pullen and Field, who have all contributed to our knowledge of different regions. This chapter is prefaced by a quotation from the writings of Plinius Minor:—"It appears to me a noble employment to rescue from oblivion those who deserve to be eternally remembered, and by extending the reputation of others, to advance at the same time our own." These words are the true key-note of the book from which our Brisbane Pliny—Plinius Major—has never once deviated throughout his task. It is doubtless no small compliment to any man to have his deeds held up in the light of "eternal remembrance" by one of his fellows, but the task requires the delicate hand of a judicious fellow; and we fear that our Pliny has marred the compliment in the paying. So inspired with veneration for his patron is he that every act of his appears almost extraordinary, and his name too august ever to be mentioned without the humblest obeisance expressed in the constant recapitulation of his titles, dignities, and office, which must be as nauseous to

FIG. 1.—Native suspension bridge across the Vanapa river.

[1] "British New Guinea." By J. P. Thomson, F.R.S.G.S., &c. (London: George Philip and Co., 1892.)

that officer as to every reader of Mr. Thomson's book. In this "noble employment," however, we hope that our historiographer for Papua may reap the reward hoped for by his prototype.

The next two chapters deal with Sir William Macgregor's explorations in the Louisiade and D'Entrecasteaux archipelagoes. In Chapter IV. is an account of the pursuit and punishment of the natives of Chads and Cloudy bays for the murder of European traders visiting their shores. The noisy with the "joyous shouts" of "merry children"! It is difficult to comprehend why Australian writers on New Guinea will so persistently—for Mr. Thomson is not the only author who thus sins, nor have we quoted the only specimen of this style of writing in his book—overlaud the capabilities and "the vast natural and artificial resources" of the country, heedless whether they may induce their too trustful readers to embark in hopeless enterprises in this "never, never land."

Fig. 2.—Highlanders of Mount Musgrave.

country lying to the south-east and north-west of Port Moresby forms the subject of the following two chapters. Speaking of that portion to the south-east Mr. Thomson says, "It may not be altogether unreasonable to assume that in the future . . . fields once the scene of battle and feudal strife may be beautified by sites of local industry and manufacture, and enlivened by the joyous shouts of merry children and the harmonious peals of village bells."

Fig. 3.—Fly River natives.

Quite forgetful of this happy picture, which he thinks is reasonable to expect, he sums up in the closing lines of his recapitulatory chapter the climatic aspects of the possession as "of an exceptional character, and their influence on Europeans so severe that very few constitutions can withstand their effect, a feature which will always be a great hindrance to settlement and a constant menace to life"—quite the region likely to produce European homes

The seventh chapter, containing an account of Sir William Macgregor's splendid feat of the ascent of Mount Owen Stanley, is naturally the most interesting portion of the book. During this expedition almost if not *the* only native bridge yet known in New Guinea was met with. It was suspended from trees on each bank, and is very similar in every respect to those built by the Malays of Sumatra and the Dyaks of Borneo. How elegant and picturesque a construction it is may be seen by the illustration on page 345.

On Mount Musgrave friendly relations were established with the highland tribes, and a photograph of great interest and value, which we are personally in a position to pronounce very characteristic, was obtained by Mr. Goodwin. This also, through the courtesy of the publishers, we are enabled to reproduce here (Fig. 2). Sir William

Macgregor says that the features of these people, which are "remarkably good, indicate more character and strength than those of the coast man, and the cheek bones in many are rather broad and prominent. The nose is generally of the semitic type, with nostrils either not arched or much more so than is usual in Papuans. The chin and under jaw are stronger." They may be compared with the Fly river people, also here figured (Fig. 3).

European names were bestowed on the chief physical features of the country passed through by the expedition "of necessity," because of its "entire unacquaintance with their orthography (*sic*) through limited intercourse with the native inhabitants." This being in Dr. Macgregor's case evidently a right and sufficient reason for the nomenclature bestowed, how can Mr. Thomson with justice animadvert, as he does on an earlier page, on the fact that "the most important affluents [of the Kemp-Welch river] have received [from Mr. Cuthbertson] European appellations ? . . . . This disregard of the native nomenclature is, in the interests of geography, much to be regretted." However, we are pleased to learn that the European names selected by the administrator have been bestowed "upon the broadest national sentiment, as being compatible with the principles which prompted the bestowal of an English name on the range by the officers of H.M.S. *Rattlesnake*." It is not improbable that the explorer of the Kemp-Welch felt the same necessity, and was actuated by the same broad sentiment. Evidently the actor here sanctifies the act. We must, however, take exception to the statement made by Mr. Thomson that it was to the *range* that the name Mount Owen Stanley was given. It is evident from observations in his book, that the author is aware of the discussion that followed on the reading of Dr. Macgregor's paper on his ascent of the mountain before the Royal Geographical Society in London. On that occasion the president of the society clearly pointed out that this name was bestowed, as has been marked on all maps for forty years, on the *peak*, not on the *range*. Throughout the book this imperious disregard for nomenclature is exhibited. D'Albertis' name of Snake Point in the Fly river has without reason been changed to D'Albertis Junction ; Annabel Harbour, close to Boundary Cape, although marked on the official map of Sir Peter Scratchley's voyage to the north-east coast, becomes Douglas Harbour ; Fort Harbour, Clayton Inlet in Porlock Bay, and the peaks named on the same occasion, as well as the region delineated by the present writer at the base of Mount Owen Stanley, are also all ignored on the map attached to the volume now being considered. One fails to comprehend what principle except personal feeling the author has followed, on the one hand in his agreeing to the change of the thoroughly established Mount Owen Stanley to a new name, and on the other, in his restoring to the Aird river, which had recently been re-christened the Douglas, the name given to it by Captain Blackwood half a century before. Not only are these arbitrary changes an unwarrantable violation of the laws of nomenclature, but they are in the remover an illegitimate assertion of authority over previous fellow-explorers, as well as an assumption of an honour to which he has no title.

Mr. Thomson has drawn on the face of his map two large red circles, from purely arbitrary centres of the equally arbitrary radius of $6° 8' 56''$, which are tangential somewhere in the valley of the Strickland river. It is impossible to divine their purpose, except perhaps to form a seasonable puzzle for his readers.

The writer of this notice feels entitled to remark on the following observation, occurring on page 109:—"Although great care was exercised, the expedition was unable to identify places on the Owen Stanley range, named and described by Mr. Forbes. We are reluctantly constrained to omit these names." In the Proceedings of the Royal Geographical Society, which Mr. Thomson quietly ignores, the writer has already pointed out that along the route by which the administrator approached Mount Owen Stanley, it would have been impossible to have seen the features "named and described by Mr. Forbes." Mr. Thomson, posing as a court of geographical appeal, has graciously condescended to intimate that if these names had been "judiciously and appropriately applied to well-defined places," they "would have received full recognition" from him. "It is also," he continues, "regretable that in describing localities to which he assigns positions, that explorer has omitted to supply the data employed in their determination." To every unprejudiced person it must be evident that the map published by the writer could not have been plotted in England without data, any more than that of Sir William Macgregor, who has not supplied to the general public, so far as the writer knows, the data by which his localities are fixed. It will be time, however, to submit to Mr. Thomson these data, when it is acknowledged that a back parlour critic of a country in which he has never set foot is a competent judge of either the judiciousness and appropriateness of the names applied, or the accuracy of the localities, or the data on which they are based.

Chapters VIII., IX., and X. are devoted to an account of the administrator's ascent of the Fly river, and of his visit westwards to the Anglo-Dutch boundary, and the eleventh to his voyage along the north-east coast. D'Albertis long ago gave us a very accurate account of his 400 mile navigation of the Fly river. Sir William Macgregor carried his flag right to the German territory, and added several unknown rivers and new mountains to the map ; but both in this region, as on the north-east coast, his voyages, though they contributed many additional facts, added little essentially new to the observations of his predecessors, except his account of the piratical Tugere tribe, living on our boundary line west of the Fly river, of whom so much had been heard but so little known.

This handsome volume, which presents us in a collected form with the record of the important contributions, geographical and biological, of a most energetic officer, to our growing knowledge of New Guinea, would have been more valuable and welcome, even in its restricted range, but for the bias unduly exhibited throughout its pages, the verbiose platitudes by which it is marred, and the extreme looseness of its descriptions, as "Morna [an island] is of the usual formation," "features of oriental type," "the Papuan dialect," and such-like expressions, which are numerous. In a long appendix we have a *résumé* of the results of the geological, botanical, and some of the zoological collections made by Sir W. Macgregor and others. Of these the chapter by Mr. Etheridge, Government Palæontologist of New South Wales, is specially valuable. Several important zoological groups, however, such as the birds, are, curiously enough, entirely disregarded. Vocabularies of many of the dialects spoken in widely separated districts of the possession are given, and are very valuable, and we sincerely hope that no opportunity may be lost of amplifying them. In fine, we regret to feel that this work will not yet relieve those who desire to make themselves acquainted with the accurate and complete history of British New Guinea, from the labour of searching through the original reports of the explorations, not of the administrator alone, but of the many other equally trustworthy workers who have contributed to its records.

HENRY O. FORBES.

NOTES.

PROF. R. VIRCHOW will deliver the Croonian lecture before the Royal Society on March 16, the subject to be the position of pathology among the biological sciences.

WE greatly regret to have to announce the death of Mr. G. M. Whipple, Superintendent of the Kew Observatory. He died on Tuesday night after a long illness.

THE *Journal of Botany* records the death, on January 18, at Brighton, of Dr. Benjamin Carrington, the highest authority on British Hepaticæ.

DR. H. J. JOHNSTON-LAVIS has been appointed Professor of Vulcanology in the University of Naples. A chair of vulcanology existed for some time at Catania, but was abolished on the death of Prof. Silvestri.

SOME important work with regard to technical education in London was done by the London County Council on Tuesday. The Council began the consideration of the recommendations of the special committee appointed to investigate the subject, and adopted the following proposals—that the Council should devote to technical education some portion of the funds from time to time recoverable under the Local Taxation (Customs and Excise) Act, 1890; that, in order to promote efficient and united action, it is desirable that the Council should delegate, so far as is permitted by law, its powers in respect of technical education to a composite body, to be called the Technical Education Board, to be appointed by the Council, partly from its own members and partly from other persons whose co-operation is desired; and that the Board should be appointed for a term of three years. It was agreed that the City Companies should be asked to contribute to the funds for technical instruction a fair proportion of their corporate income as distinguished from their trust property.

ON Saturday the overhead electric railway at Liverpool was opened by Lord Salisbury, who afterwards delivered a very effective speech on the great things which are likely to be achieved for mankind by electricity.

THE London Amateur Scientific Society will hold its annual general meeting on Friday, February 10, at 7.30 p.m., at the Memorial Hall, Farringdon Street. The president will deliver an address, and the officers and council for the ensuing year will be elected. At the conclusion of the annual general meeting the ordinary meeting will be held, when objects of interest—botanical, zoological, and geological—will be exhibited.

A CONVERSAZIONE was held the other evening at Firth College to celebrate the completion of the additional building. The addition comprises new physical and biological laboratories, workshop and class rooms, and considerably increases the accommodation available for teaching purposes. The cost, £5,500, has been wholly raised from local subscriptions.

ANOTHER disastrous shock of earthquake occurred at Zante on Friday last. It was followed by a terrific thunderstorm, accompanied by rain and hail. All the ovens in the island were destroyed by the successive shocks, so that no bread or biscuits could be made. Thousands of the inhabitants have been made homeless. On Monday there were three further shocks. The King and Queen of Greece have visited several of the villages, and have been deeply affected by the scenes of utter ruin and desolation which have everywhere met their eyes. On Tuesday they visited the naphtha springs of the island, which are believed to be the centre of the disturbance. The mayor of the village of Deme Elatia, some distance from the town of Zante, telegraphed that a large chasm, from which smoke was constantly issuing, had been discovered near that place.

DURING the first part of the past week the weather in these islands was under the influence of barometrical depressions situated in the north-west. Rain fell in most places, and the temperature exceeded 50° in the south and west, and even reached 56° in London. On Friday an anticyclone which lay over the Baltic, spread westwards, and under its influence the temperature became much lower, sharp frosts occurring at night over England, the readings on the grass in the southern part falling as low as 17°, but in the north and west the day temperatures were between 45° and 50°. The weather in the southern parts of the country became bright and fine, with local fogs, which extended as far as central England. During the early part of this week depressions from the Atlantic again skirted our western coasts in a north-easterly direction, causing south-westerly gales in the north and west, and a considerable increase in temperature, the maxima on Monday exceeding 50° in Ireland and the extreme south-west of England. The depression rapidly increased in intensity, and by Tuesday the warm south-west winds had spread over the whole country, the rise of temperature amounting to over 20° in the south-east of England. A bright aurora was observed in the north-east of Scotland on Sunday night. The *Weekly Weather Report* of the 4th instant shows that the temperature exceeded the mean in all districts during that week. Bright sunshine did not differ materially from the mean in any district, the percentage of possible duration ranged from twenty-five in the south-west, to twelve in the east of England.

THE *American Meteorological Journal* for January contains an article by Prof. D. P. Todd bearing upon the selection of stations for observing the total eclipse of April 16 next, together with a map showing the entire region of visibility. He has gone to considerable trouble in collecting data, especially cloud observations for the month of April, for the last three years, together with particulars respecting the stations and the best means of reaching them. The utility of a systematic examination of the cloud conditions of the eclipse localities is apparent. It is only in this way that the best observing stations can be selected.

THE meeting of the American Psychological Association at the University of Pennsylvania on December 27 and 28 seems to have been very successful. According to a writer in the New York *Nation*, no one who attended the meeting failed to be impressed with the quite unusual enthusiasm of the members and the still more unusual peace and serenity that prevailed in all the discussions. This writer is of opinion that, apart from Dr. Sanford's observations on dreams, the paper of most general interest was President Hall's account of the history and prospects of experimental psychology in America. A "breezy stimulus" was brought to the meeting by Prof. Hugo Münsterberg, of Harvard, who has recently gone from Freiberg to be director of the Harvard Psychological Laboratory. He stirred up a vigorous discussion upon the very foundations of experimental research. This discussion, as well as others, was enriched by the contributions of Prof. Titchener, of Cornell. The next meeting of the association is to be held at Columbia College, New York, during the Christmas recess, 1893.

THE Annual Report of the Botanical Department, Jamaica, has just been published. The Director, Mr. W. Fawcett, F.L.S., has a good deal to say about the work of his Department, one of the oldest and most successful in the colonies. It was started as long ago as 1777, and ever since, as Mr. Fawcett recalls, it has successfully "introduced valuable exotics, and the productions of the most distant regions to the West Indies," and laid the foundations of the present prosperity in place of the poverty which followed the abolition of slavery. The work of establishing the Hope Gardens as the headquarters of the Department near Kingston is still kept in view, although the amount allowed for this purpose appears much less than the Director considers desirable, taking into account the present importance of the island. A hill garden is looked upon as essential to the development of the high lands in Jamaica, and Mr. Fawcett shows that as about one-half of the total area of the island is above 1000 feet elevation, it is impossible to ignore the

legitimate claims of those who are engaged in cultural industries above that limit. Good progress has been made in the scientific work connected with the herbarium and library, and numerous subjects, such as the extension of grape culture, the distribution of valuable economic plants, experiments in onion and tomato culture, fodder plants for the hills, have received attention. Students from Harvard University were engaged during the year in studying and making collections of tropical plants, and one of these devoted himself to preparing glass models of flowers and fruits with dissections to illustrate the science of botany. Two apprentices, natives of Lagos, West Africa, were attached to the Hope Gardens, with the view of qualifying themselves to take charge of botanical stations in their own country.

Mr. Fawcett's opinion respecting the practical aims and functions of departments like his are conveyed in the following words: "Botanic Gardens in the tropics do the work on the plant side of Agricultural Departments in temperate climates. They are in themselves experimental stations, and are much more efficient in introducing new cultural products, and in distributing plants and imparting useful information than most agricultural departments. The whole of the Botanic Gardens in the British Empire are more or less in communication with one another, exchanging seeds and publications, and all look up to the Royal Gardens at Kew as to their head for advice and assistance. Imperial Federation is already in existence as regards the Botanical Gardens and their work. If any special variety of plant or any new culture comes into notice information and plants are sought either directly from the local institutions, or more probably through Kew as the botanical clearing house. The Director of Kew has at his disposal the services of experts in every branch of botanical inquiry, and he is always most willing to assist colonial establishments in every way. Besides, any intricate question that arises in chemistry, in diseases of plants, in insect pests, in the commercial value of new products, can nearly always be determined by reference to Kew. Colonial botanical gardens are therefore not isolated units, but branches of an organisation as wide as the British Empire itself."

The first part of "A Handbook to the Flora of Ceylon," by Dr. H. Trimen, F.R.S., director of the Royal Botanic Garden, Paradenyia, will shortly be published. It will be illustrated by twenty-five coloured plates, and the entire work is intended to consist of four similar parts.

The first number of *Erythea*, a new monthly botanical journal for Western America, has been published. It is edited by Mr. Willis L. Jepson, under the direction of members of the botanical department of the University of California.

Mr. T. Southwell records in the February number of the *Zoologist* the occurrence of Sowerby's whale (*Mesoplodon bidens*) on the Norfolk coast. On December 19 last he received a telegram stating that a strange "fish" was ashore at Overstrand, near Cromer; and on the following day he and Mr. S. F. Harmer, of the Museum of Zoology and Anatomy, Cambridge, went to Overstrand, where they found an adult female of this rare species. About 8 a.m., on Sunday, December 18, one of the Overstrand fishermen saw from the cliff an object lying in shallow water near the beach, which he at first took to be a log of wood, but soon perceived to be a large "fish." After obtaining assistance, he fastened a noose over its tail and secured it by an anchor, till it was placed on a trolley and drawn up the gangway to a shed on the cliff where the visitors saw it. The animal was alive when first observed, but died before it was taken from the water. Before the arrival of the visitors it had been eviscerated, and a very advanced fœtus removed from it. The total length of the old female, measured in a straight line to the centre of the tail, was 16 feet 2 inches, and that of the young one 5 feet 2 inches; across the flukes of the tail the adult measured 3 feet 8 inches. The present, says Mr. Southwell, is the nineteenth known example of this remarkable animal, all of which have been met with in the North Atlantic during the present century; but, with the exception of one taken in 1889 at Atlantic City, which came into the possession of the United States National Museum at Washington, and of which no account has, he believes, at present been published, in no other instance has an example in perfect condition come under the notice of a cetologist. Individuals or their remains have been found in Scotland and Ireland, but the only previous English example was met with at the mouth of the Humber in September, 1885.

Colonel H. W. Feilden, in the course of an interesting paper on animal life in East Greenland, contributed to the February number of the *Zoologist*, suggests, as he has done before, that the Musk-ox might with advantage be introduced into Great Britain. He sees no reason why it should not thrive on the mountains of the Highlands of Scotland. In the winter season the Musk-ox is covered with a long-stapled fine wool in addition to its coat of hair. This wool is of a light yellow colour, and as fine as silk. Sir John Richardson states that stockings made from this wool were more beautiful than silk ones. Young Musk-oxen are very easily reared and tamed, and, Colonel Feilden thinks, there could not be any great difficulty in catching either old or young in Jameson's Land.

Governor Flower has recommended that all of the New York State's pecuniary contributions to agriculture should be turned over to Cornell University, with power to apply the same in such a manner as the trustees and faculty of that institution may devise. To the New York *Nation* this seems an excellent suggestion. The agricultural disbursements from the State Treasury, except the portion specifically set apart as premiums for agricultural fairs, have become, it says, as distinctly a part of the "spoils system" of politics as the work on the canals or the appointments of wardens in the State prisons. The Dairy Commission was started with an appropriation of 10,000 dollars for the purpose of suppressing oleomargarine. The expenditure has grown to 100,000 dollars per year, while the fight against oleomargarine is not a whit more effectual than it was in the beginning.

The Government of Cape Colony has now at work, in charge of its own experts, eight water-boring diamond drills, and there is a great demand on the part of farmers for the use of the instruments. Experiments have been made on twenty-seven farms, on twenty-two of which water has been found. The *Agricultural Journal* of Cape Colony says that the results have sometimes been astonishingly successful. On a farm in the division of Colesberg, for instance, three holes were sunk, the first two unsuccessfully. In the third, however, the water was struck, first at 2 feet 6 inches, then at 8 feet 6 inches, then at 16 feet, then 22 feet, then 32 feet 6 inches, and on reaching a depth of 47 feet a stream of water shot up above the ground, gauged at 21,600 gallons in twenty-four hours, delivered through a 1-inch pipe, and with every indication of the supply proving permanent. In most cases the water is of excellent quality. Some exceedingly interesting experiments are about to be tried in Bushmanland by the Government. Sites are now being selected for a line of boreholes right across the country. It is well known that the veld makes splendid sheep-runs after occasional rains, and should the experiments prove successful, the value of the land will be greatly increased. With respect also to the Government railway grant of 6000 square miles of land in Bechuanaland, it is intended that water shall be bored for there as soon as drills can be set at liberty.

Prof. O. C. Marsh gives in the February number of the *American Journal of Science* an interesting restoration of

Anchisaurus, the skeleton chosen for the purpose being the type specimen of *Anchisaurus colurus*, which the writer has already described. This restoration, as shown on an accompanying plate, indicates that *Anchisaurus colurus* was one of the most slender and delicate dinosaurs yet discovered, being only surpassed in this respect by some of the smaller bird-like forms of the Jurassic. The restoration, Prof. Marsh thinks, will tend to clear up one point long in doubt. The so-called "bird-tracks" of the Connecticut river sandstone have been a fruitful subject of discussion for half a century or more. That some of these were not made by birds has already been clearly demonstrated by the fact that the impressions of fore feet, similar to those made by reptiles, have been found with them. Although no osseous remains were found with them, others have been regarded as footprints of birds, because it was supposed that birds alone could make such series of bipedal, three-toed tracks and leave no impression of a tail. It is now evident, however, says Prof. Marsh, that a dinosaurian reptile like *Anchisaurus* and its near allies must have made footprints very similar to, if not identical with, the "bird-tracks" of this horizon. On a firm but moist beach, only three-toed impressions would have been left by the hind feet, and the tail could have been kept free from the ground. On a soft, muddy shore, the claw of the first digit of the hind foot would have left its mark, and perhaps the tail also would have touched the ground. Such additional impressions the writer has observed in various series of typical "bird-tracks" in the Connecticut sandstone, and all of them were probably made by dinosaurian reptiles. No tracks of true birds are known in this horizon.

THE U.S. Secretary of the Interior, in his report, just issued, for the fiscal year ending June 30, 1892, refers to a good many subjects of more than passing interest. Speaking of Indian educational work during the year, he states that it has been greatly extended and improved. The attendance of Indian children in school has increased over 13 per cent., the enrolment for 1892 being 19,793 as against 15,784 in 1889. Five new Indian reservation boarding schools have been established during the present administration, and are in successful operation, and six others are in process of establishment, and it is anticipated will be opened soon. Six non-reservation schools have also been established and others are being prepared. The standard, character, and ability of all *employés* have been greatly improved, as have also the appliances and equipments for the proper training of Indian pupils and the efficient administration of the Indian school service. A uniform system of text-books and course of study has been adopted, and a compilation of the rules for the conduct of the schools has been prescribed. The interest in the welfare of the Indians has been constant and the work in their behalf persistent; and the Secretary thinks that this has resulted in their being raised still nearer to civilisation.

THE U.S. Geological Survey, according to the Secretary for the Interior, has had a very marked effect on the mining industries of the country. The increase in value of mineral products during the past year was 75,000,000 dollars, and the increase during the thirteen years since the institution of the survey is 300,000,000 dollars. While a part of this development represents the normal growth of the population and industries, the increase is much more rapid than that of population, and is, moreover, accompanied by a decided relative decrease in importations of mining products; indeed, the mining products of the country have more than doubled during the past thirteen years, while the population has increased only 30 per cent. The secretary, therefore, thinks it fair to ascribe a material part of the present industrial activity in extracting and utilising mineral resources to the services of the Geological Survey through its correspondence, and especially through its widely distributed maps and reports. The cost of mineral production during the past year has been reduced about 15 per cent., and during the period since the institution of the survey no less than 40 per cent., a saving to the consumers of mineral products amounting to millions of dollars annually being thus effected. A considerable part of this saving must be ascribed to the diffusion of exact information concerning mineral localities by the geological surveys of the Federal Government and several of the States.

DEALING with the state of the Seal Islands, the Secretary for the Interior says that during the season of 1892 only 7500 seals were killed on the islands, and that the diminished number of seals upon the rookeries shows the terrible waste to seal life in the destructive methods employed in pelagic sealing. Heroic measures, he maintains, are necessary for the preservation of the sealing industry. In 1890 no less than 50,000 seals were taken in the sea, and more than that number in 1891. Every seal taken in the ocean represents many more destroyed, and the 52,087 taken in the ocean in 1891 indicates the destruction of 300,000 more, three-fourths of which were females.

THE accumulation of ice in winter, blocking harbours, estuaries, &c., interferes greatly with the commerce of Northern peoples. The idea arose to make steamers which should break a temporary path through the ice, and in Gothenburg (Sweden) such a vessel was built in 1881. In the severe winter of 1885 it made a wide passage between that town and Vinga, on the open sea, through an ice-bank about a foot thick, which it charged at a speed of about 8½ knots an hour. Christiania has been led to get one of these ice-breaking steamers; also Oersen in Denmark, and Stockholm. The *Murtaja*, recently built for Stockholm (and described in *Génie Civil*), acts both by its weight in charging the ice-bank, and by its spoon-like bow resting on the ice and crushing it. The hull is divided into compartments, those at the bow and stern serving as reservoirs for water, which is transferred from the one to the other by a pump. With the stern-reservoir full, the draught of water at the stern is about 21 inches; at the bow about 15 inches. When the bow rises on the ice the water is quickly brought forward to add to the weight. It need hardly be said the bow, and indeed the whole of the hull, are made very strong, the material used being Swedish scrap iron and Martin steel.

IT is known that sewage water, spread over irrigation-fields, reappears from drains placed at a few feet depth, in a limpid state, like spring water. This water, unlike that of sewers, proves remarkably favourable to fishes, probably because of its dissolved organic matter, which the filtration in the soil has not wholly removed. This fact has been lately observed by Herr Oesten on the irrigation farm at Malchow, near Berlin, where the water is collected in eight ponds; and in these ponds salmon and carp have flourished greatly.

IN determining the thermal conductivities of liquids, two methods have been employed. In the one, a column of liquid is warmed at the top and the rate of propagation downwards through the column is observed. In the other, the lamellar method, which was first employed by Guthrie, a thin layer of liquid is placed between two conducting surfaces. Mr. R. Wachsmuth has shown, by means of an ingenious piece of apparatus, that in the first method currents in the liquid are unavoidable. The apparatus, as described in *Wiedemann's Annalen*, consisted of a beaker placed inside another containing water. The inner beaker was filled with water and blue iodide of starch, which has the property of suddenly turning colourless when heated to a temperature somewhere between 30° and 70°C. according to the degree of dilution. A copper cylinder was placed on the rim of both beakers so that its bottom was in contact with the surface of the emulsion. When steam was

made to pass through the cylinder, a colourless stratum was seen to extend downwards from the surface. The separating surface was sharply defined at first, but after a few minutes a number of secondary stratifications appeared, which on close inspection showed wavy outlines. Many of them were of a deeper blue, *i.e.* cooler, at their upper than at their lower surfaces, so that there was evidence of a vortex-like motion in the liquid. For really trustworthy results Mr. Wachsmuth used an arrangement of two copper plates and a thermopile, the lower plate being placed in contact with ice.

THE volume on "The Partition of Africa," by Mr. J. Scott Keltie, which has been for some time in preparation, will be issued in a few days by Mr. Stanford. The work, which has been brought thoroughly up to date, is illustrated by a carefully-selected series of facsimiles of early maps, as well as by a number prepared specially to show the present condition of the continent in its many different aspects.

MR. A. E. SHIPLEY, Fellow of Christ's College, Cambridge, and Demonstrator of Comparative Anatomy in the University, has been for some time engaged on an illustrated text-book of invertebrate zoology, which will be published (Adam and Charles Black) early in the spring. It is specially adapted for the use of University students reading for such examinations as the first part of the Natural Sciences Tripos, or for the B.Sc. degree in London.

MESSRS. MACMILLAN AND CO. have published a second edition of Mr. D. E. Jones's "Examples in Physics." The book has been carefully revised, and some sixty pages of matter have been added. New sets of problems from recent papers have been put in the place of the examination questions at the ends of the chapters.

THE first volume of the *Seismological Journal* is now in the press, and will shortly be issued. It is uniform in size and in character with the Transactions of the Seismological Society, and will correspond with what would have been volume XVII. of those publications had they been continued. The yearly subscription for the journal is 5 yen, 5 dollars, or £1. This includes delivery or postage. It may be paid by P.O.O. or a draft on any foreign bank in Yokohama. Address, John Milne, 14, Kaga Yashiki, Tokio.

MESSRS. WHITTAKER AND CO. have published "The School Calendar and Handbook of Examinations, Scholarships, and Exhibitions, 1893." This is the seventh year of issue. A preface is contributed by Mr. F. Storr.

A DEFINITELY crystallised compound of iron and tungsten of the composition FeW_2 is described by Drs. Poleck and Grützner, of the University of Breslau. The crystals of this interesting substance were discovered in drusy cavities of a massive piece of a crystalline iron-tungsten alloy containing no less than 80 per cent. of tungsten. The alloy had been prepared by an electrolytic process from *wolframite* at the works of Biermann's Metal Industry in Hanover, and exhibited in the numerous cavities small but very well-formed crystals of a silver-grey colour and exhibiting very brilliant faces. They were extremely heavy and of exceptional hardness. Upon analysis they yielded numbers corresponding closely with those calculated for the compound FeW_2. Dr. Milch, of the Mineralogical Department of the University, subjected the crystals to a goniometrical investigation, and found them to consist of trigonal prisms whose faces were inclined exactly at 60°, and which were terminated by a basal plane inclined exactly at 90°. Singularly, however, no other faces were ever discovered upon them, so that it was impossible to ascertain to what sub-section of the hexagonal system the crystals belonged. The crystals are so hard that they readily scratch topaz, and appear to be of about the same hardness as corundum.

THE discovery of these crystals of a definite compound of iron and tungsten, and the fact that they are endowed with such a high degree of hardness, afford a ready explanation of the long-known property of tungsten in improving the hardness of steel. Berzelius, in his *Lehrbuch*, already remarked that tungsten readily formed alloys with most of the other metals, and in the year 1858 Muchet in this country took out a patent for the employment of tungsten in the manufacture of steel. Thereupon the wolfram minerals, previously considered as almost worthless, rapidly came to acquire a considerable value. Bernoulli has since shown that tungsten is capable of alloying in all proportions with iron until it reaches a proportion of 80 per cent., when the mass becomes infusible even at the hottest procurable white heat. This alloy containing so high a percentage of tungsten, approximating indeed to that (86·4) contained in the crystals above described, exhibits a silver-grey lustre like that of the crystals and possesses almost the same hardness, scratching glass and quartz with ease. Latterly the manufacture of this alloy has been carried on at the Hanoverian metal works above referred to, and brought into commerce. There can be little doubt that the remarkable property of tungsten in increasing the hardness of steel is due to the formation of more or less of this compound FeW_2, and the nearer the proportions of the two metals approach to those of the compound itself the more nearly does the resulting alloy approach in hardness to that displayed by the crystals of FeW_2 above described.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*, ♀) from India, presented by Capt. U. Cooke; a Two-spotted Paradoxure (*Nandinia binotata*) from West Africa, presented by Lady Fleming; a Brush-tailed Kangaroo (*Petrogale penicillata*, ♂), two Black-striped Wallabys (*Halmaturus dorsalis*, ♀♀) from New South Wales, presented by Mr. Wilberforce Bryant; a Mauge's Dasyure (*Dasyurus maugæi*) from Australia, presented by Mr. Robert Hoare; a Red and Yellow Macaw (*Ara chloroptera*) from South America, presented by Mr. H. H. Dobree; a Grey Parrot (*Psittacus erithacus*) from West Africa, presented by the Executor of the late Mrs. Bolaffe; an Æthiopian Wart Hog (*Phacochœrus æthiopicus*, ♂) from Matabeleland, South Africa, deposited; two Chukar Partridges (*Caccabis chukar*, ♂♀) from North-west India, presented by Major Ingoldsby Smythe; fourteen Prairie Marmots (*Cynomys ludovicianus*, 6♂8♀) from North America, an Arctic Fox (*Canis lagopus*) from the Arctic Regions, two Rufous Tinamous (*Rhynchotus rufescens*) from Brazil, purchased; three Black and Yellow Cyclodus (*Cyclodus nigro-luteus*), three Diamond Snakes (*Morelia spilotes*), a Short Death Adder (*Hoplocephalus curtus*), a Purplish Death Adder (*Pseudechis porphyriaca*), a North Australian Banded Snake (*Pseudonaia nuchalis*) from New South Wales, received in exchange.

OUR ASTRONOMICAL COLUMN.

COMET HOLMES (1892 III.).—During the past week no very important change has taken place in the appearance of the comet; the following is the current ephemeris:—

Ephemeris for 12h. M.T. Paris.

1893.	R.A. app. h. m. s.	Decl. app. ° ′ ″
Feb. 9	... 1 56 29·3 ...	+34 0 28
10	... 1 58 3·3 ...	2 18
11	... 1 59 37·8 ...	4 12
12	... 2 1 12·8 ...	6 9
13	... 2 48·3 ...	8 9
14	... 4 24·4 ...	10 13
15	... 6 0·9 ...	12 20
16	... 2 7 37·9 ...	34 14 30

Mr. Fowler writes from South Kensington:—"The comet on February 6 was a very dim nebulosity without sensible nucleus."

COMET BROOKS (NOVEMBER 19, 1892).—The following is the ephemeris for Comet Brooks for the ensuing week:—

Ephemeris for 12h. M.T. Berlin.

1893.	R.A. app. h. m. s.	Decl. app. ° ′	Log *r*.	Log Δ.	Br.
Feb. 9 ...	0 11 33 ...	+30 2·9 ...	0·1167 ...	0·1832 ...	1·40
10 ...	13 19 ...	29 31·2			
11 ...	15 1 ...	29 0·9			
12 ...	16 40 ...	28 31·8			
13 ...	18 15 ...	28 4·0 ...	0·1252 ...	0·2152 ...	1·16
14 ...	19 47 ...	27 37·3			
15 ...	21 17 ...	27 11·6			
16 ...	22 44 ...	26 46·9			

SPECTRA OF PLANETARY NEBULÆ AND NOVA AURIGÆ.—In the December number of the *Memorie della Società degli Spettroscopisti Italiani*, among many interesting communications, is one by M. Eugen Gothard, relative to the great similarity between the spectra of the late Nova and the planetary nebulæ. By the aid of a 10½-inch reflector and a 10-inch objective prism, together with Schleussner's orthochromatic plates, he has been able to obtain these photographs, the wave-lengths of the lines of which are given in the table below. In the memoir copies of the photographs on a somewhat larger scale are given, that of the Dumb-bell nebula (G.C. No. 4447) showing the image of the nebula itself, just as if no prism had been used. The wave-lengths of the Nova given in this table were obtained from photographs taken on September 27 with 2h. 15m. exposure, and on October 28 with 3h. exposure, and, in M. Gothard's words, "gave the surprising result that the spectrum of the new star perfectly agrees with that of the planetary nebulæ."

The following is the table of the wave-lengths, lines I., II., VI., and VII. representing the nebula lines, and III., IV., and V. the hydrogen lines:—

		I.	II.	III.	IV.	V.	VI.	VII.
(1) G.C. No. 4447 ...	—	502	—	434	411	396·5	386·5	373
(2) „ 4964 ...	—	501	470	434	409	397	386·5	—
(3) „ 4373 ...	—	502	—	434	410	396·5	386·5	373
(4) „ 4514 ...	—	502	—	434	410	396·5	385·7	371
(5) „ 4628 ...	—	501	468	434	408·5	396	386·5	372
(6) N.G.C. „ 7027 ...	—	500·7	464	434	410	395	385·7	—
(7) „ 6891 ...	—	502	—	434	410	396	386·5	372
(8) „ 6884 ...	—	500·5	—	434	—	395	386·5	—
(9) Nova	582	500	464·2	434	407·7	395	385·5	372

SUN-SPOTS AND MAGNETIC PERTURBATIONS IN 1892.—In an article under this heading in *Astronomy and Astrophysics* for January M. Ricco brings together the facts relative to these two phenomena, the magnetic perturbations being taken from the photo-magnetographs of the United States Naval Observatory. As the author describes in detail both kinds of observations, and in addition, a tabulated statement of the records, we cannot do better than abridge the table, by omitting the numerical statements as to the magnitudes of the spots and perturbations, leaving our readers to refer if necessary to the journal itself.

In the column "spots" this means principal spots; E denotes extraordinary; V.L, very large; L, large; M, medium; S, small; and N, none.

Transit Centre Meridian.	Spots.	Helio-graphic latitude.	Time of Maximum.	Mag. Pertur-bations.	Retar-dation in time.
		°			h.
Jan. 4, 2 p.m. ...	V.L	+20	Jan. 6, 4 a.m.	V.L	38
Jan. 28, 3 p.m.	L	−16	Jan. 29, noon ...	L	21
Feb. 2–4	N	—	Feb. 2–4	S	—
Feb. 12, 4 a.m.	E	−30	Feb. 14, 1 a.m.	E	45
March 1–5 ...	N	—	March 1–5 ...	M	—
March 7, 2 a.m.	N	—	March 7, 2 a.m.	L	—
March 10, 2 p.m.	E	−29	March 12, 11 a.m.	V.L	45
April 23, 8 p.m.	L	+11	April 25, 11 p.m.	L	51
April 24, 4 p.m.	L	+16	April 26, 1 p.m.	L	45
May 1–2	N	—	May 1–2	M	—
May 16, 5 p.m.	E	−16	May 18, 6 p.m.	E	49

From this table some very interesting facts may be gathered. Out of the eleven cases which M. Ricco gives, no less than seven instances occur where the passage of the spots over the central meridian is followed by a terrestrial magnetic disturbance, and not only this, but the magnitudes of both vary directly. The point which the author wishes to emphasize most is the apparent constancy of the interval of time between these two phenomena, and an important fact is that at both appearances of the great February spot the same retardation occurred. In the above table, with the exception of January 29, the mean interval is 45½ kms., "thus indicating a velocity of propagation from the sun to the earth of about 913 kms. per second," or "more than 300 times less than that of light."

NEW MINOR PLANETS.—Photography seems to be rapidly increasing the number of our minor planets, that is to say, if the announcements really refer to new ones. Wolf and Charlois between them have discovered five this year, the former two (1893 B and C), the latter three (1893, A, D, and E).

THE LUNAR SURFACE.—At the present day the general idea with regard to the peculiar features of the moon is that they are the results of stupendous volcanic actions, the number and activity of which surpassed anything that we can imagine. Owing to the extraordinary circularity in the craters, ring plains, walled plains, and to the well-known fact that many of the craters have not the raised lava floor half-way up or near the summit of the cone, which is such a typical terrestrial characteristic, doubt as to their volcanic origin has often been raised. In a small pamphlet which we have received from Mr. S. E. Peal, Sibsagor Assam, the author suggests a "theory of glaciation" in the light of recent discoveries with regard to the maximum surface temperature, and also to the non-viscosity of ice at low temperatures, together with the admitted possibility of snow existing on the moon. The author assumes the moon to be constituted somewhat like our earth, and at one time to have been at a higher temperature, having an atmosphere, water, &c., and draws attention to the facts that there are no polar caps; that colour is conspicuous by its absence, "a feature quite opposed to terrestrial experience, except at the poles," and therefore "may not the entire globe be swathed in snow?"; and the absence of river valleys and drainage sculpturing, indicating that a piling up of dry material has taken place in opposition to a fluvial erosion. At the time when the lunar globe had so far cooled down as to be practically rigid, the tidal action would gradually turn all continents and land surfaces into shoals, and at the temperate stage of development the growth of the polar caps would be restricted to the shallows, extending from them as the temperature became reduced. This advancing sheet of ice would sometimes be deformated by submarine heat vents resulting in a large or small bay, depending on the magnitude of the vent. Extending seawards the "horns of the bay would meet around and enclose this area of higher mean temperature, converting it into a lagoon." Nocturnal radiation and solar heat alternately would perhaps freeze and thaw the ice formed thereon, and with a rare atmosphere and intense cold aqueous vapour would arise from "the water (floe-covered) floor during the day at least, and be carried over the ice edge by diffusion when the fall in temperature would precipitate it into snow, thus gradually forming a vast rampart." Century after century would see the level floor gradually lowered, and the ramparts increased in height. The author accounts for all the peculiar forms of craters, walls, &c., by different local conditions (*i.e.* land or water or submarine vents), but they are all the result "of water floors left in a slowly extending glaciation of the crust."

GEOGRAPHICAL NOTES.

AT the French Congress of Learned Societies, which meets on April 4 at the Sorbonne, the section of historical and descriptive geography, is to be devoted specially to the early geographical conditions of France, and to the work of French travellers. The programme includes the consideration of the earliest traces of human habitations, maps of caverns, &c., and proceeds to classify existing dwellings according to their situation and altitude. Local names in danger of falling out of use are to be collected, and the limits of the old districts such as Brie, Beauce, Sologne, &c., to be investigated in order to place on record the geographical conditions which led to their formation.

IN the *Scottish Geographical Magazine* for February Mr. J. G. Goodchild gives a most interesting description of a large-scale topographical model of the site of Edinburgh, which he has recently constructed. The model, which is on exhibition

in the Museum of Science and Art, Edinburgh, is based upon Bartholomew's map of Edinburgh on the scale of 15 inches to a mile, but the altitudes are taken point by point from the large town plans of the Ordnance Survey. The model is in many ways original in its mode of construction. Its object is purely geographical, having been suggested by a leading citizen as a method of showing the contrast between the circuitous roads and frequent steep gradients of the old coaching days, and the straighter and more level lines of communication by which modern engineers have overcome the restraint of physical configuration.

IN the same number of the *Scottish Geographical Magazine* there is a paper on the Deserts of Atacama and Tarapaca, read to the Society by Mrs. Lilly Grove, and some interesting notes on South Eastern Alaska by Prof. J. J. Stevenson, illustrated by a map.

MR. H. J. MACKINDER'S third educational lecture for the Royal Geographical Society was given on Friday night, the subject being the belt of Steppe which traverses Asia from west to east. He showed how the distinctive physical and climatic conditions of the Steppe favoured the growth of nomadic nations, every man of whom was a member of the most mobile cavalry force which ever existed. Pastoral pursuits and marauding were natural to the Steppe peoples, and the descent of their hordes on the settlements bordering the Steppe were turning-points in the history of surrounding nations. Reference to the successive periods of conquest by the Scythians, Huns, Turks, and Mongols showed the power of these nomads on the affairs of other countries, and until the advent of the Steppe-bred Cossacks no western power has ever secured control of the central Asian plains.

FOLLOWING on the death of Captain Stairs we have to record the death of his fellow-officer in the Emin relief expedition, Mr. R. H. Nelson. Mr. Nelson returned to Africa, and was in charge of the district of Kikuyu in Ibea, when he succumbed to an attack of dysentery on December 26, 1892.

THE INSTITUTION OF MECHANICAL ENGINEERS.

THE first general meeting for this year of the Institution of Mechanical Engineers was held on Thursday and Friday evenings of last week, the 2nd and 3rd inst., in the theatre of the Institution of Civil Engineers.

There were two papers set down for reading, as follows:—"Description of the experimental apparatus and shaping machine for ship models at the Admiralty Experimental Works, Haslar," by R. Edmund Froude, of Haslar; "Description of the pumping-engines and water-softening machinery at the Southampton Waterworks," by William Matthews, waterworks engineer.

After the disposal of the usual formal business, the President (Dr. William Anderson) referred to the International Engineering Congress which was to be held in Chicago during the month of August next. He had received a letter from Mr. James Dredge, of London, who had been elected honorary president of the congress. Every one, Dr. Anderson said, knew of Mr. Dredge, so there was no occasion for him to say anything further on that head; but he trusted that English engineers would take steps necessary to a creditable representation.

The next business was an alteration in the bye-laws, the chief referring to the class of membership. Hitherto the institution has consisted of members, associates, and graduates. The two latter classes are, however, of small importance and practically the institution is composed of full members. The qualification for membership was that the candidate should be an engineer not under twenty-four years of age; so that a member might be a Great George Street magnate, or the head of a big engineering firm, down to a draughtsman or the foreman of a machine shop, supposing of course he were an engineer and not simply a mechanic or artisan. These conditions of equality do not appear, however, to meet the views of the council of the institution, so there are to be two classes of engineers on the register, the big and the little. These are to be known respectively as members and associate members, but as far as we can see the broad distinction is that the member has achieved success whilst the associate member has still his way to make. Honour to whom honour is due is a good maxim, but it may be doubted whether the practically self-elected council of an irresponsible body should be the arbiters, not only of fame, but of professional status.

Resolutions embodying the proposed changes were moved from the chair, and carried unanimously. It need not be said that the new rule is not retrospective.

These matters having been settled, the secretary proceeded to read Mr. Froude's paper describing the apparatus in the Haslar establishment, over which he presides. To make clear the details of mechanism given would be quite impossible without the aid of drawings. These were supplied at the meeting in the shape of wall diagrams, but as members had not an opportunity of studying them beforehand, there were very few who were able to keep up with the reading of the paper, excepting those who already knew all about the matter. This is too often—we may say generally—the case in meetings of the technical societies; excepting always the Institution of Civil Engineers. Before this Society a paper is read on one evening, and, if its importance be sufficient, it is discussed during three sittings, each a week apart. Members have therefore an opportunity of grasping the details of the papers read, and preparing what they have to say beforehand. It is for this reason that the discussions before the Civil Engineers have always been instructive.

Mr. Froude's paper deals with but a fragment of its subject, but it takes the part which was more especially of interest to his audience, namely, the mechanical details involved in the apparatus used for testing the models by which a forecast is made of the performance of future naval vessels. It is well known that these forecasts are made possible by the late Mr. Froude's discovery of the law of "corresponding speeds," so that the speed, with a given power, of the full-sized ship can be deduced from the performance of the model. The way in which the late Mr. Froude carried out his investigations, and how the original experimental works grew up at Torquay, under the wise encouragement of the Admiralty, are well known to all interested in physical science. It would be difficult to overestimate the good that has followed this work; for one thing it has done much to put us on an equality with our old rivals, the French—long, indeed, our masters in the science of ship design. Perhaps there is nothing upon which we could better found our claim to naval supremacy—in this long era of naval peace—than the possession of the only naval testing tank of its kind. It is a distinction we shall probably not long be able to boast, for the Russians, Italians, and Americans all contemplate constructing establishments of a like nature.

The paper commences with describing the principal features of the present Admiralty experiment establishment at Haslar. As at the former works at Torquay, the chief object consists of a long covered water-way, in which models of ships are towed to ascertain their resistance. The towing is done from a dynamometer carriage driven at definite speeds by a stationary engine working a wire rope. The models are made of hard paraffine, generally about 14 feet long, and something upwards of 1 inch in thickness as finished. They are cast in a mould with an allowance of about $\frac{1}{4}''$ for finishing the shape. The latter operation is done by hand, guidance grooves being cut in the model, so that the exact form may be preserved. The working of this shaping or copying machine, and the way in which it enables the lines of a drawing to be translated into model form, constitute one of the most interesting parts of the installation. The water-way, canal, or tank at Haslar is nearly 400 feet long, and of nearly uniform section throughout. The sides are of concrete and vertical, and the railway, on which the dynamometer carriage runs, is bedded on the tops of the side walls of the water-way, in place of being suspended over the water from the roof, as in the original design. The experimental carriage, which has to be nearly 21 feet gauge, is a trussed structure. Its principal peculiarity consists in the fact that the members of the several trusses composing it are wooden trunks or boxes about 4″ square in cross sections, made of $\frac{3}{8}''$ deal, and put together with screws and shellac varnish. At the joints formed by the intersection of the various members of the trusses, the sides of the boxes are made to overlap one another over a large area, providing a large surface for screwing and for the adhesion of the shellac varnish. The dimensions of the boxes forming the several members of the girders are designed so as to bring the sides of the boxes into the right planes to suit these overlaps. The whole structure thus provided is remarkably rigid and light. The general design of the carriage is arranged so as to leave clear a sort of central alley provided with a railway, the rails of which are close to the sides

of the alley. The object of this secondary railway is to carry the smaller carriages, on which are mounted the actual experimental apparatus of different kinds; so that these may be adjusted on this railway to any desired position fore and aft on the main carriage. The carriage is driven by means of wire rope from a stationary 10″ Tower spherical engine, a high power being required so as to start the truck quickly for high speed experiments. The ordinary speeds range between 100 and 500 feet per minute; for some classes of models experiments are occasionally made up to about 850 feet per minute or nine and a half miles per hour. The truck has been run at over 1200 feet per minute, or about fourteen miles per hour. The governor, by which the speed of the engine is regulated, is a very interesting and ingenious piece of mechanism, which has been modified from the design of that which was used on the engine at Torquay. There are two symmetrical bell-cranks carrying weights, and attached to each other by links, having slotted holes so as to allow the bell-cranks to have a very small range of freedom of angular motion. When a given speed of rotation is reached, the centrifugal force of the weights overcomes the tension of a spiral spring, provided for the purpose, and the governing action is brought into play in the following manner:—There is a hooked rod, by means of which the increase in the angular altitude of the weights (due to centrifugal force) brings a friction disc break into play, which in turn has the effect of extending a spiral spring connected with the engine throttle valve, which is thus closed so as to shut off steam. It will be easily seen how much more delicate an adjustment this device gives than the old Watt governor with the balls acting directly on the valve. The extension of the spring, and the consequent distance of departure of the throttle valve from its full open position are proportional to the frictional turning movement applied to the stationary wheel, which movement is itself proportional to the pressure brought to bear upon it by the bell-cranks; in other words it is proportional to the excess of the speed above that at which the centrifugal force of the weights just equals the tension of the spiral spring. To give greater sensitiveness of action the bell-cranks are not hung on pin joints but on flat springs after the fashion of a clock pendulum, safeguards being provided in case of the springs breaking. With the Torquay governor, which was similar in principle to that described, although differing in appearance, the adjustment was so delicate that a variation of speed in the running of the carriage of half a foot per minute was seldom exceeded even at the highest speeds. The value of working against the resistance of spiral springs will be noticed in this mechanism, their steadying action being especially valuable. It would be impossible for us to attempt to describe the mechanism constituting the copying apparatus of the model shaping machine, and we can only hope to give a mere outline of the general principles. A rough hollow model of the ship to be constructed is cast in paraffine wax, a material which is found to lend itself most perfectly to the necessities of the experiments. The drawing from which the operator has to work is stretched on a table, and the grooves representing the water lines are copied from the drawing by means of the mechanism. These grooves are formed by a pair of revolving cutters, the fore and aft motion being communicated to the model whilst the cutters move laterally. One cutter is on each side—for of course full models are required—and they approach or recede symmetrically in such accordance with the longitudinal travel of the model as to trace in plan upon it the intended horizontal section. This due accordance of the lateral motion of the cutters with the longitudinal motion of the model is accomplished by the operator so regulating the cutter motion as to maintain a tracer in contact with the corresponding water-line on the drawing. By suitable mechanism the drawing itself is made to imitate the longitudinal travel of the model, while the tracer imitates the lateral travel of the cutters. In the Torquay machine the tracer was guided by an adjustable template set to the curve of each water-line, but afterwards the tracer was made to follow the line on the drawing by the operator. In the present machine the cutters are raised or lowered to get the different water-lines. The cutters run at 2700 revolutions per minute. The grooves having been cut, the surplus material is removed by hand.

We shall not follow Mr. Froude in his description of the further details of the mechanism, as it would be unintelligible without the drawings by which he illustrated his description. The various arrangements are, however, fully worthy of study by all who are interested in ingenious mechanical devices; but we must refer our readers to the printed transactions of the institution, in which the diagrams will appear when the volume is published. There is also a weighing machine, which is necessary to obtain the actual dead weight of the model, so that the amount of ballast required to get the necessary displacement corresponding to trial draught may be determined. This machine will weigh up to 1000 lbs. with great accuracy, and is similar in principle to an ordinary chemical balance, except that it is a steel yard, having one arm 6 inches and the other 5 feet in length.

The discussion on this paper was opened by Mr. W. H. White, the Director of Naval Construction, who is the official head of the Admiralty department, of which the Haslar establishment forms a branch. Mr. White spoke of the advantage these model experiments had been to the navy, saying that the great advance in the speed of ships which had been obtained of late years would not have been reached to the full extent had it not been for the model experiments carried out at Torquay and Haslar by the late Mr. Froude and his son, the author of the paper. Mr. J. I. Thornycroft also pointed out the great economy that had been made in expenditure upon navy ships by finding out beforehand what the proposed vessel would do, and what was required in the way of power to reach that performance. Mr. Thornycroft made especial reference to the ingenuity of the device whereby a line on the drawing, which might not be quite accurate, would be made to give the desired result in the model, and this without an expensively-constructed apparatus. Various other speakers having been heard, and Mr. Froude having briefly replied, so far as there was anything to reply to, the meeting adjourned until the next evening.

On the members assembling on Friday evening, the 3rd inst., the president, Dr. Anderson, again occupied the chair, and Mr. Matthews's paper on the Southampton waterworks was read. This contribution is interesting, as it describes what we understand is the largest water-softening plant yet installed. The quantity of water that can be satisfactorily dealt with is from $2\frac{1}{4}$ to $2\frac{1}{2}$ million gallons per day of 24 hours. Of course the principle of softening hard water by lime is very far from new, but it has made slow progress, in spite of the vast quantities of hard water, otherwise unobjectionable, that there are in the chalky southern half of our island. This limited application of a means whereby a bad water in one respect can be made a good one in all respects does not appear, to judge by the proceedings of last Friday, to spring from any inherent defect in the system—beyond that which would arise from the disposal of the refuse lime in crowded cities—but rather from the carelessness of public authorities and water-supplying companies to the wants and comforts of the people at large.

The meeting terminated with the usual votes of thanks, the President announcing that the summer meeting would be held this year at Middlesborough on Tuesday, August 1, and the following days.

THE SEVEN IMAGES OF THE HUMAN EYE.

IT is well known that in the human eye, besides the refracted image, which serves the purposes of vision, there are formed three reflected images known under the name of "Purkinje's images." M. Tcherning has discovered three additional ones, so that the total number is brought up to seven.[1]

In its passage into the interior of the eye each ray of light has to pass through the cornea, the aqueous humour, the crystalline lens, and the vitreous humour before finally arriving at the retina. At the surface of each of these constituents the ray is liable to be partially reflected, thus giving rise to four reflected images. These were all seen and described by Purkinje at the beginning of the century, but only three were observed by Helmholtz and others. These three can be easily observed by two persons on holding a lighted match between their eyes, and moving it about so that the reflections seem to come from the pupil. One of them, that reflected by the front of the cornea, is much brighter than the two others, which are formed by the front surfaces of the crystalline and the vitreous humour respectively. The fourth image is due to reflection from the posterior surface of the cornea. It may be discovered by careful observation of the brightest image by means of a magnifying glass. As

[1] See *Séances de la Société Française de Physique*, Avril-Novembre, 1892.

it approaches the border of the pupil, and especially as it passes on to the iris, it is seen to be accompanied by a small, pale, but well-defined image, which always lies between the first image and the centre of the pupil, the distance between them decreasing as they move towards the centre, where they finally coincide. By means of the ophthalmophakometer—an instrument consisting of three incandescent lamps and a telescope arranged on an arc of 86 cm. radius—it was found possible to measure the radii of curvature of all the reflecting surfaces. The foci of the two reflecting surfaces of the cornea were found to coincide, a fact which accounts for the coincidence of the two corresponding images at the centre of the pupil, and for Helmholtz's failure of finding the fainter one.

It is evident that since the light reflected from the successive surfaces does not fall upon the retina, it is lost for visual purposes. But a comparison of the percentages of loss in the case of the eye, and in that of a simple lens tells greatly in favour of the former as an optical instrument. In the eye the percentage of useful light is 97, in a simple lens 92, and in a compound optical instrument correspondingly less. But the light reflected by any of the internal surfaces is also liable to be reflected back into the eye or the optical instrument, with the effect of superimposing a more or less faint patch of light upon the image on the retina. This is termed the noxious light (*lumière nuisible*) by M. Tcherning. In a simple lens this amounts to $\frac{1}{8}$ per cent., whilst in the eye it is as low as 0·002 per cent. But faint as it is, it is capable of giving rise to two light impressions due to double reflection, one at least of which has been actually observed in the human eye. "The easiest way of observing it," says M. Tcherning, "is to look straight forwards in a dark room, holding a lighted candle in the hand about 20 cm. from the line of vision. On moving the candle gently from side to side a pale image of the flame is seen on the opposite side of the line of vision, distinct enough to show that it is inverted; it moves symmetrically to the candle with respect to the line of vision. The rays which form this image have undergone, besides several refractions, two reflections, one at the posterior surface of the crystalline and another at the front surface of the cornea." Another image was expected to be formed by a similar reflection at the anterior surface of the crystalline. It was found in an artificial eye, but not in the human sense-organ. However, an easy calculation of the optical system of the eye explains this circumstance. The focus of the reflected rays is very near the crystalline lens itself, so that they must be much dispersed by the time they reach the retina. To enable the image to be formed on the retina, the object would have to lie between the cornea and the crystalline, but on attempting to form a luminous point at that place by optical means it is found that the "useful rays" fill the eye to such an extent as to render everything else invisible.

It is found that different eyes differ in their capacity of seeing the first of the two additional subjective images. Short-sighted people find it very indistinct unless the candle is held close to the eye, or convex glasses are used. As the maker of optical instruments utilises the accessory images for testing the degree of polish and the accurate centreing of the lenses, so the physician is enabled to make valuable inferences from them as to the structure and condition of the eye he is examining, and the additional images discovered by M. Tcherning appear to be of considerable physiological importance. E. E. F. d'A.

A BOTANIST'S VACATION IN THE HAWAIIAN ISLANDS.

SOME weeks ago we reprinted from the *Botanical Gazette* (Indiana) a part of the first instalment of Prof. D. H. Campbell's interesting account of his vacation in the Hawaiian Islands. The following is the chief portion of the second and concluding instalment, published in the January number:—

Beside visiting the isle of Oahu, I made short trips to the islands of Hawaii and Kauai. The former, the largest of the group, and the only one where volcanic action is still going on, is reached by steamer in about thirty-six hours from Honolulu. On the way, the islands of Molokai, Lanai, and Maui are passed. The first, a barren-looking and forbidding spot, is the location of the leper settlement, to which all persons afflicted with leprosy are sent as soon as their condition becomes known.

Maui, the largest of the islands next to Hawaii, consists of two portions connected by a narrow isthmus. The whole eastern half is nothing more nor less than the body of an immense extinct volcano, ten thousand feet high, and with a crater nearly ten miles across. The other end of the island is an older formation. This island is said to be very interesting botanically; but, unfortunately, my time did not permit me to visit it.

Very soon after sighting Maui, the three great mountain masses of Hawaii began to loom up. The day was clear, and the whole formation of the island became visible. It consists of three great volcanic cones, of which only one is now active. The highest summit, Mauna Kea, is nearly 14,000 feet above the level of the sea; the next, Mauna Loa, lacks but a few hundred feet of this; yet so great is the breadth of these masses that one fails to realise their immense height. Our first landing was at Mahukona, on the leeward side of the island, a most forlorn expanse of bare lava with scarcely a trace of vegetation, except a few unhappy-looking algaroba trees planted about the straggling buildings that constituted the hamlet.

We lay all day at this inhospitable station, not getting away until evening. A beautiful sunset and a fine glimpse of the peak of Mauna Kea glowing with the last rays of the sun, form my most pleasant recollections of this desolate place.

What a change the next morning! On awakening we found ourselves entering the harbour of Hilo. Here everything is as green as can be imagined, and luxuriant vegetation comes down to the very ocean's edge. The town is built on a bay fringed with cocoa-nut trees and embowered in a wealth of tropical vegetation. Owing to the great annual rainfall (about 180 inches), as well as to the fact that Hawaii is the most southerly of the islands, the vegetation here is the most luxuriant and tropical found in the whole group. I remained in Hilo for six days and collected some most interesting specimens. Through the kindness of Mr. Hitchcock of Hilo, I was enabled to spend the night at his camp in the woods near the town, and the greater part of two days collecting in the vicinity. The forest here is most interesting. Mr. Hitchcock was starting a coffee plantation and has cut trails through the woods in several directions, so that collecting was very convenient. There is great danger of losing one's self in these woods where there are no trails, as much of the forest is an almost impassable jungle. In these moist forests ferns and mosses luxuriate, and every trunk and log is closely draped with those beautiful growths. Flowers are almost entirely wanting, a fact repeatedly observed by collectors in tropical forests. I saw here fully developed specimens of tree-ferns. The finest of these were species of Cibotium. Many had trunks from fifteen to twenty feet high, and some must have been fully thirty. The most beautiful were some with trunks ten to fifteen feet high, as these were more symmetrical and had finer fronds than the taller ones. I measured the leaves of one that had fallen over, and roughly estimated the length as eighteen feet. I have no doubt that specimens fully twenty feet long could be found. These giant fronds, arching high over one's head as one rides on horseback under them, present a sight at once unique and beautiful. Growing upon the trunks of these ferns were many epiphytic species, the most peculiar of which was *Ophioglossum pendulum*, with long strap-shaped leaves, a foot or two long, and a spike of sporangia sometimes six inches long. Exquisite species of Hymenophyllum and Trichomanes, the most ethereal of all the fern tribes, with almost transparent, filmy leaves, were common, sometimes completely enveloping the trunks of the trees. Of the terrestrial ferns, which abounded everywhere, two were especially notable as representing groups unknown in the United States. One of these, *Gleichenia dichotoma*, forms extensive thickets on the borders of the forest, and in the Hilo district extends down almost to the sea-level. The other, *Marattia Douglasii*, a very large fern with leaves eight to ten feet long in well-grown specimens, has fleshy dark green leaves, and thick stipules sheathing the base of the leaf-stalks. Several species of Lycopodium and Selaginella were common, and a good variety of mosses and liverworts. In these forests wild bananas are common, and most magnificent plants they are. Sheltered from the wind, the superb great leaves develop to their full size, without being torn in the least, and the whole plant is a study of beautiful form and colour.

Coffee is being extensively planted in this region as well as upon the lee side of the island, and as the quality of the berry

is exceptionally fine, this promises soon to be a leading industry in the islands.

About Hilo especially, but common also elsewhere, was a very conspicuous black fungus, that covered the leaves completely in many cases, and attacked indiscriminately a great variety of trees.

From Hilo I proceeded to the volcano of Kilauea, some thirty miles distant, and about 4000 feet above the level of the sea. As this volcano has so often been the theme of travellers' descriptions I will not linger over it. In the vicinity are many interesting plants, among them a species of Vaccinium with sub-acid yellow and red berries something like cranberries. These "ohelo" berries are much esteemed, and are especially good when cooked. Some two miles from the volcano is a superb grove of koa trees, the largest trees I saw anywhere in the islands. One of these standing alone, and with magnificent spread of branches, must have been ten feet in diameter. The road to the volcano lies for much of the way through a fine forest. In the lower part the ohia trees were loaded with their beautiful crimson fruit, and present a very showy appearance. Of flowers, the species of Ipomæa were the most conspicuous; but the scarlet flower-bracts of Freycinetia were conspicuous at times, for here this latter plant may often be seen running to the tops of the tallest trees.

The glory of this road, however, is the tree-ferns, which all along excite one's admiration. The carriage road is not yet completed, and about thirteen miles must be done on horseback. Of this more than a mile is over a corduroy road made out of the trunks of ferns! Such a road, if not very durable, is yet very pleasant to horses. As these trunks lay prostrate, in the damp atmosphere, most of them were already sending out new fronds, and in due course of time the road will be fringed with a hedge of great fern-leaves. Indeed, in some of the more open parts of the road farther down, where the ground is completely occupied by a small tree-fern growing in dense thickets, as these are grubbed out to make way for cultivation, their trunks are piled up to form fences, and soon sprout out so that they make a beautiful and close hedge of fern-leaves.

On leaving the volcano I went down on the other side of the island. The rain being almost entirely intercepted by the mountains, this leeward side is very dry, and the ride to Punaluu, where we were to take the steamer, was not especially pleasant. Vegetation is very scanty, and nothing particularly interesting was noted in this line. The soil on this side of the island, especially in the district of Kona, is very fertile, and when water can be had, produces magnificent crops of all the tropical staples, pine-apples, cocoa nuts, coffee, sugar, &c., all especially fine; and we feasted on these cocoa-nuts and pine-apples as we sailed along this picturesque, if somewhat barren, coast.

A short, flying trip was made to the Island of Kauai, the richest botanically of all the islands, as it is the oldest geologically. According to Hillebrand, not only is the number of species larger than in the other islands, but the species are more specialised. Here I saw several species of the curious woody Lobeliaceæ, of which there are several genera that form either shrubs or small trees. I saw several species of Cyanea, with stems six to eight feet high, with long leaves crowded at the top of the stem and many white or purplish flowers, much like those of Lobelia, but somewhat larger and less open.

As in all the islands, there is on Kauai a great difference between the windward and leeward sides. I drove for about thirty miles along the windward side of this island through some of the most beautiful scenery of all the islands. Near the sea were rolling plains and hills, with here and there groves of Pandanus and Hau—the latter a dense spreading small tree with large yellow hibiscus-flowers—and at one point we drove through a magnificent grove of kukui trees, the finest I saw anywhere. As we reached that part of the island which is most fully exposed to the moisture-laden trade-winds, vegetation became extremely luxuriant. Numerous valleys with clear streams flowing down them, their bottoms given up to rice plantations, were to be seen here, with the rice in all stages, from the young spears just standing above the water to golden-yellow patches of ripe grain. At Hanalei, my destination, I found excellent accommodation and a delightful bathing beach, the latter especially attractive after a thirty-five mile drive over dusty roads. Hanalei is beautifully situated on a picturesque bay, with bold mountains rising directly back. The next morning a native was hired to go with me into the woods, and the day was spent in collecting. The variety of trees, as well as other phænogams, is much greater here than in Hawaii; the ferns, also, were very fine. Here I obtained a prize in a fine lot of the prothallia and young plants of Marattia, as well as some other interesting things.

Want of space forbids going into details, but no botanist visiting the islands can afford to miss Kauai.

In position, the Hawaiian Islands are unique, being more isolated than any other land of equal area upon the globe. More than 2000 miles separates them from the mainland, and 1860 miles from the nearest high islands. Of purely volcanic origin, thrown up from an immense depth, they have always been thus isolated. As might be expected, the flora is very peculiar, more so than in any other country. According to Hillebrand, of 800 species of spermaphytes and pteridophytes that are strictly indigenous, 653, or 75 per cent., are endemic. Taking out the pteridophytes, the spermaphytes show over 81 per cent.; and the dicotyledons over 85 per cent. that are found only in this group.

For a thorough study of this very curious flora, a long time would be necessary, as many species are extraordinarily local, and many of the most interesting localities are very difficult of access. The islands differ extremely among themselves, and exhibit in a most interesting manner the correspondence that exists between the variety and differentiation of forms and the ages of the islands. The formation of the islands has proceeded from north to south; and Kauai, the northernmost of the large islands of the group, is also the oldest and much the richest botanically, especially as regards spermaphytes; and, according to Hillebrand, the genera and species are more differentiated. Hawaii, the southernmost of the islands, is much the poorest in forms, although in the Hilo district the conditions are most favourable for a luxuriant development of forms.

In the latter island is the last active volcano of the group, Mauna Loa, with its two craters, of which the well-known crater of Kilauea is the great sight of the islands, and visited constantly by tourists from all parts of the world.

A few days after my return to Honolulu from Kauai, and six weeks from my first arrival there, I boarded the *Monowai*, the through Australian steamer bound for San Francisco, which was reached in due season after an uneventful passage. And so ended my first trip to the tropics.

INSTRUMENTS FOR THE EARTHQUAKE LABORATORY AT THE CHICAGO EXPOSITION.

THE first earthquake instrument ever invented, a drawing of which is shown on the wall, is in all probability that of Chōkô, dating from the year A.D. 132. The first instrument used for keeping systematic records in Japan was Palmieri's modification of the contrivance sketched out by the late Robert Mallet. Since this not only have all forms of seismographs and seismoscopes employed in Europe and America been employed, but many special forms have been designed in Japan, with the result that rather than Japan borrowing from Europe and America, these countries are using inventions which had their origin in Japan. A few of these instruments are exhibited in this laboratory. The main feature in their construction is that they all work from "*steady points*," and for small earthquakes at least, we can say with confidence that the diagrams they yield are absolute measurements of the earth's motion. From diagrams written on stationary plates we know the extent and the direction of the principal vibrations in a shock, but when the movements are recorded on a moving surface, we know the period or the rapidity with which the movements follow each other. From these latter diagrams the acceleration or suddenness of movements may be calculated, and the factors given to engineers enabling them to construct to resist known forces, rather than simply building strongly because an earthquake is strong.

INSTRUMENTS EXHIBITED.

1. *Seismograph writing on a glass disc.*—Here we have horizontal pendulums writing the earth's motion as two rectangular components on the surface of a smoked glass plate. The vertical motion is given by a vertical spring lever seismograph. The rate at which the plate revolves is accurately marked by an electrical time ticker. The movements of the latter are governed by a pendulum swinging across and making contacts with a small vessel of mercury.

The revolving plate is kept in motion by clockwork, which is set in motion by an electric seismoscope. (See No. 8.)

2. *Seismograph writing on a drum.*—In this instrument the record is written on a band of paper, the diagram being less difficult to interpret because it is written to the right and left of a straight line and not round a circle.

3. *Seismograph writing on a band of paper.*—In this instrument not only is the diagram written along a straight line but it is written with pencil,—the trouble of handling smoked paper being therefore avoided. When the earthquake ceases, the drum ceases to revolve, but if a second or third earthquake should occur, it is again set in motion. By this means a series of earthquakes may be recorded, the resetting of the instrument being automatic.

4. *Seismograph without multiplying levers.*—This instrument is intended to record large motions, the horizontal levers not being prolonged beyond the steady points to multiply the motion. For large earthquakes, when the ground is thrown into wave-like undulations, special instruments which measure tilting are employed.

5. *Duplex pendulum seismograph.*—In this case a steady point is obtained by controlling the motion of an ordinary pendulum with an inverted pendulum. The record consists of a series of superimposed curves written on a smoked glass plate.

6. *Mantelpiece seismometer.*—This is intended for the use of those who simply wish to know the direction and extent of motion as recorded at their own house. It is a form of duplex pendulum, and it gives absolute measurements for small displacements.

7. *Tromometer.*—This is one form of an instrument which is used to record movements which are common to all countries, called earth tremors. Every five minutes, by clockwork contacts and an induction coil, sparks are discharged from the end of the long pointer to perforate the bands of paper which are slowly moving across the brass table. If the pointer is at rest, then a series of holes are made following each other in a straight line, but if it is moving, the bands of paper are perforated in all directions round what would be the normal line of perforations.

The earth movements which cause these disturbances are apparently long surface undulations of the earth's crust, in form not unlike the swell upon the ocean.

A more satisfactory method of recording these motions, which has been used for the last two years, is by a continuous photograph of a ray of light reflected from a small mirror attached to a small but extremely light horizontal pendulum.

8. *Electrical contact maker.*—These instruments are delicate seismoscopes, which on the slightest disturbance close an electric circuit, which, actuating electric magnets, set free the machinery driving the recording surfaces on which diagrams are written.

9. *Clock.*—At the time of an earthquake the dial of this clock moves quickly back and forth and receives on its surface three dots from the inkpads on its fingers. It thus records hours, minutes, and seconds, without being stopped.

10. *Model of an earthquake.*—The bent wires represent the path traced by an earth particle at the time of the earthquake of January 15, 1887. The numbers indicate successive seconds. This model was made by Prof. S. Sekiya.

11. *Safety lamps.*—These are lamps which if overturned are at once extinguished. One of these is a European invention and the other Japanese.

12. *Pictures.*—The pictures on the walls show the effects of the Great Earthquake of October 28, 1891, the devastation following the Eruption of Bandaisan in 1887, and several of the more important volcanoes in Japan. They were made by Prof. W. K. Burton.

JOHN MILNE, F. ŌMORI.

Seismological Laboratory, Imperial University of Japan, Tokio.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Last Term the Board of Faculty of Natural Science recommended that an honour examination in Natural Science should be instituted, bearing the same relation to the Final School that Moderations bear to the Final School of Literae Humaniores. The recommendation of the Board was not unanimous, and on the matter coming before the Hebdomadal Council last week, it was put aside on the ground of want of unanimity among the various scientific departments. There was much to be said both for and against the proposed examination. It would probably have raised the standard of the chemical and physical work done by biologists, but would have forced an additional subject on the chemists and physicists, which they were very unwilling to assent to.

CAMBRIDGE.—The Adams Prize has been awarded to Prof. J. H. Poynting, F.R.S., late Fellow of Trinity College, for a memoir on the methods of determining the absolute and relative value of gravitation and the mean density of the earth.

The Professor of Pathology (Mr. Roy) gives notice that on Thursday, February 9, a lecture and demonstration will be given by Dr. Hafkine, of the Pasteur Institute, on his method of conferring immunity against Asiatic cholera. The lecture will be delivered at the Pathological Laboratory at 4.30, and will be open to members of the University.

The office of Esquire Bedell has been rendered vacant by the death of Mr. F. C. Wace, a distinguished mathematician, formerly Fellow and Lecturer in Mathematics at St. John's College, and thrice elected Mayor of the Borough of Cambridge.

SCIENTIFIC SERIALS.

Wiedemann's Annalen der Physik und Chemie, No. 1.—Essay towards an extension of Maxwell's Theory, by Hermann Ebert. The author obtains expressions for dispersion and absorption of waves of the order of light-waves analogous to those obtained by Goldhammer, and shows that they may be derived from Maxwell's fundamental conceptions by applying them to the case of rapidly changing displacements.—A new kind of magnetic and electric measuring apparatus, by G. Quincke. These are made of glass, ebonite, and wood. No screws are used in their construction, and they are claimed to cost a tenth of the price of ordinary instruments, with equal accuracy. In each of them the needles are suspended at the hollow centre of a vertical circular glass disc.—On a null method for measuring the dielectric constants of conducting liquids, by Friedrich Heerwagen.—On a phenomenon analogous to Newton's rings observed during the passage of Hertz electric plane waves through plane-parallel metal plates, by Ludwig Boltzmann. The author removes an apparent contradiction between Maxwell's theory and Hertz's observation that even excessively thin metal plates do not transmit electric waves a few decimetres long, by showing that this is not due to absorption, but to the limiting conditions at the surfaces of separation deducible from Maxwell's formulæ.—On a medium whose mechanical properties lead to the equations propounded by Maxwell for electromagnetism, by L. Boltzmann.—On some questions concerning Maxwell's theory of electricity, by L. Boltzmann.—The index of refraction of electric rays in alcohol, by H. O. G. Ellinger.—On the electrification of air in glow and brush discharges, by Ad. Heydweiler.—On the calculation of magneto optic phenomena, by P. Drude.—Spectra of aluminium, indium, and thallium, by H. Kayser and C. Runge.—On the infra-red spectra of the alkalies, by H. Kayser and C. Runge. A criticism of Benjamin Snow's work on the same subject.—Investigations concerning interior conduction of heat, by Richard Wachsmuth.—On the absolute value of the thermal conductivity of air, by A. Winkelmann.—On a modification of the transpiration method suitable for the investigation of very viscous liquids, by C. Brodmann. The substance was made to pass from a funnel-shaped reservoir through a capillary tube into a beaker standing on one pan of a chemical balance. The time was noted at which the amount of liquid passed into the beaker was large enough to overcome the counterpoise in the other pan, and to disturb the equilibrium, and further small weights were added and similarly dealt with. The temperature was kept constant by a spiral water-pipe and felt jacket, and local differences and variations of level and buoyancy were corrected for. The liquid experimented upon was glycerine, and the temperature curves were hyperbolas.—Notes on M. Cantor's thesis on capillary constants, by Th. Lohnstein.—Note on the purification of mercury, by W. Jaeger.

Notes from the Leyden Museum.—Of volume xiv. numbers 1 and 2 were published in April, and numbers 3 and 4 in July last. Edited by Dr. F. A. Jentink, this volume contains 282 pages and ten plates. The notes on Mammals are; by the editor on *Semnopithecus pyrrhus*, Horsfield; and on *Pithecir melanurus*, S. Muller (Pls. 3 and 4). In volume xii. Dr. Jentink,

p. 222, gave a note about this latter very rare, nearly forgotten, and often misunderstood little rodent, figured by Alfred Duvaucel in F. Cuvier's great work, the "Histoire Naturelle des Mammiferes." Cuvier could give no indication of its size, nor of its native country, guessing that "qu'il est originaire des provinces du Nord de Bengale, si ce n'est des parties occidentales de Sumatra." Dr. S. Müller, in 1834, obtained a specimen in Java, to the northern side of Mount Gede, and named the species. This, and another specimen from Sumatra (also collected by Müller) are both in the Leyden Museum as stuffed specimens. The skulls of these two specimens were detected in the Leyden Museum by Oldfield Thomas, and were included by Jentink in his catalogue of 1887, though with a query. But all doubt on the subject was removed at the date of this paper; and now the animal has been taken alive by Mr. J. D. Pasteur on the northern slope of the Goenong Gedeh, Java, an account of which capture is given in a very graphic translation of a letter to Dr. Jentink. On birds there are papers by J. Büttikofer on the specimens of the genus Tatare in the Museum, on the specific value of Levaillant's "Traquet Commandeur," and on the collections of birds sent by the late A. T. Demery from the Sulymah river, West Africa, pp. 13–30. In this last paper 96 species are recorded, ten of which are new to Liberia; on *Batrachostomus poliolophus*, n. sp. from W. Sumatra, by Ernst Hartert; on a weaver finch from Sumatra; and on a collection of birds from the islands of Flores, Sumba, and Rotti, by J. Büttikofer; and on the birds of Sumba, by A. B. Meyer. About fish there is a note by Dr. Th. W. van Lidth de Jeude on *Orthragoriscus nasus*, Ranzani, which had been washed ashore in November, 1891, at Callantsoog. A figure from a photograph is given.—M. Schepman describes a number of land and fresh water mollusca from Soemba, Timor, and other East Indian islands; several new species are diagnosed.—Dr. J. G. de Man continues his Carcinological studies in the Leyden Museum, and in No. 6 describes several new species which are figured. A very important contribution to our knowledge of the echinoderms is made by Dr. Clemens Hartlaub's paper on the species and structure of the hard parts in Culcita; nine species are carefully described, their geographical distribution is given, *Culcita grex*, M.T., is figured from a photograph, and a fairly complete bibliography is appended. The rest of the papers are descriptions of new forms of insects.

No. 1 of vol. xv., dated as January, 1893, but published October 30 last, contains a review of the genus Rhipidura, with an enumeration of the specimens in the Leyden Museum. A key to the 75 species now known is given—five are described for the first time. M. E. Buchner has a note on the occurrence of *Mellivora indica*, Kerr, in the Trans-Caspian district; on two supposed new species of Pentadactylus, by M. Schepman. There are also several papers on new forms of insects.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 26.—"On the Three-Bar Motion of Watt." By William Brennand. Communicated by C. B. Clarke, F.R.S.

"Further Researches in Connection with the Metallurgy of Bismuth." By Edward Matthey, F.S.A., F.C.S., Assoc. Roy. Sch. Mines. Communicated by Sir G. G. Stokes, Bart., F.R.S.

Paper IV.—"Bismuth, its Separation from Arsenic."—In melting large quantities of bismuth containing arsenic it was found that the surface of the metal being exposed to the air arsenical fumes appeared, and that as the temperature of the metal was raised the arsenic came off in dense white fumes (As_2O_3). An alloy of bismuth containing 0·65 per cent. of arsenic was carefully operated upon and freed from the whole of its arsenical contents, the temperatures being noted at which the separation takes place. When raised to a temperature of 513°C. and maintained at this for a short period, the bismuth was found to be absolutely free from arsenic.

Paper V. "Bismuth, its Separation from Antimony."—Whilst engaged in fusing some 400 or 500 kilogrammes of bismuth containing antimony it was noticed that a peculiar oily film formed on the surface of the alloy, which on being removed and tested was found to contain a considerable percentage of antimony. By continuing the operation and removing the film from time to time as it formed, the melted metal became bright, and was then found to be perfectly free from antimony. A quantity of about 350 kilogrammes of bismuth containing 0·80 per cent. of antimony was melted and the temperature observed at which the antimony separated as described. By maintaining a constant temperature of 458° C. the whole of the antimony separated, leaving the bismuth free from any trace of this metal. The temperatures were determined by the pyrometer of M. H. le Chatelier.

Physical Society, January 13.—Prof. G. F. Fitzgerald, F.R.S., President, in the chair.—Mr. F. W. Sanderson read a paper on science teaching. In this communication the author considers the methods of teaching physical science, and remarks that other sciences may best be treated in some different manner. The method recommended is one found suitable in public schools where boys may remain till about the age of nineteen. In elementary and secondary schools modification would be necessary with a view to making it more immediately useful, whilst in university and technical colleges other methods might be preferable. The object of his public school method was to make physical science a definite means of education, rather than to produce skilled physicists. Certain mathematical subjects, such as arithmetic, geometry, and algebra, should be taught before physics is begun, and taught in such a way as to aid subsequent physical work. In teaching arithmetic it is deemed desirable to distinguish between the science and the art of it, and to have separate hours for instruction in each. The subjects included in each part are described in some detail in the paper. No existing arithmetic satisfies the author's requirements. Geometry is considered of the first importance; practical geometry and the use of instruments forming the best introduction to the subject. It is recommended that the elementary part be taught by the mathematical master with a view to formal geometry, *e.g.* Euclid. As most practical geometries consist of isolated constructions they are useless for teaching the subject in a scientific manner. A number of problems suitable for a graduated introductory course are given. After elementary geometry, mensuration may be taken up with advantage, the facts being verified by drawing to scale, measuring, or by weighing, but no rules being given. Trigonometry of one angle may then be commenced. Here also free use should be made of the drawing board, each pupil finding the sines, cosines, and tangents of angles by drawing and measurement, and making tables. Quite independent of the mathematical class the author has been in the habit of carrying boys on the engineering side through a course of graphical analytical geometry, in which they draw straight lines and the quadratic curves, &c., from their equations, solve simultaneous linear equations, quadratics, cubics, &c. Other geometrical constructions follow. The subject as to what branches of science should be taught in the different departments of a school is then considered, and schemes are given for the classical, modern and commercial, science, and engineering sides. Some general principles which have been kept in view in arranging the physical teaching are next described. In the first place the fundamental experiments and observations on which each scientific law is based are explained to the pupils, and when possible the experiments are performed by the boys in the laboratory. Secondly, from the experiments the laws are stated as precisely as possible, the form of statement depending on the knowledge possessed by the class. The problem of expressing a law mathematically from its most fundamental statement is then fully considered. Thirdly, mathematical deductions from the laws are followed out, and the pupils perform experiments to verify the results, and thus confirm the laws. Fourthly, a course of exact physical measurements is given, which includes mensuration, hydrostatics, mechanics, sound, heat, electricity, and light. A first and second year's course is arranged in each subject, and in both years all the boys work the same experiment at the same time. This necessitates multiplication of apparatus, but being of a simple character in the lower forms where the pupils are numerous it is not prohibitive. It is also stated that boys get better results with comparatively rough apparatus, if large, than with delicate and expensive instruments. About half the time devoted to physics is spent in the laboratory. Mathematics is introduced, as far as can be done without straining the pupils too much, and with young classes appeal is made to experiment where the strictly logical argument would be difficult to follow. Instead of teaching the applications of science as done in some technical schools, the author's method is to teach pure science, and let the applications come in as

illustrations. At the end of the paper detailed lists of experiments for practical courses in electricity and optics are given. Samples of the apparatus used were exhibited at the meeting, those for optics being particularly simple and ingenious.—Prof. A. M. Worthington said his experience led him to a very hearty agreement with Mr. Sanderson on all essential points, and he thought there was now a close agreement amongst teachers as to the best methods. He therefore wished to ask, Had not the time now come at which the Physical Society might usefully endeavour to exert direct influence on science teaching? As the scientific instruction of a person who intends following a scientific calling is generally divided into stages, and conducted in different places under different teachers, he thought it was desirable that those in charge of his training at each stage should say up to what point his instruction should be carried before he reaches them. Other matters in which the society might do useful work were (1) reporting on text-books and condemning the bad ones, and (2) furthering the adoption of the decimal system. At present, he said, an enormous extension in the teaching of physical science is taking place, and it seemed within the power of the Physical Society to place itself at the head of the movement. Another point which required to be settled was the relative importance of physics and chemistry at different stages of a student's education.—Mr. L. Cumming agreed with the general principles laid down by Mr. Sanderson. In attempting to carry out such schemes numerous difficulties presented themselves, especially where the science master had not control over the subdivision of the boys' time. He had tried teaching the science of arithmetic to boys in the lower forms, but the results were not encouraging, for he found very few who could do much in it. They seemed to devote themselves much more readily to concrete problems and the art of manipulation of rules. Graphical statics was very valuable. As regards experimental lectures, he believed them to be very important, especially in junior classes. For scholarship boys a different method had been tried with success. Instead of performing lengthy experiments completely before the class, the essential parts were gone over, and for the minor points the results obtained in experiments made before or after the lecture were given, so that all the data for reducing the results were to hand. This saved considerable time. He had hoped Mr. Sanderson would say something about the slide rule, and wished to learn his opinions on its use.—Dr. Stoney said he was very much struck with the methods of teaching brought forward by Mr. Sanderson, and remarked that his own work would have been considerably lightened if such a scheme had been developed many years ago. Experimental methods were very valuable, provided the inaccuracies of measurement be kept in view. Plotting curves was also very instructive, and might be made a means of furnishing the fundamental notions in the differential and integral calculus. As to the introduction of chemistry, his experience went to show that this should be done at an early age. Dynamics should also be begun early.—Mr. W. B. Croft thought that if the Society did make rules to regulate the teaching of physical science, these rules should not be too strict, for the ages and aims of boys might differ widely. At Winchester the science teaching was carried out on the lines recommended by a committee of the Royal Society appointed to consider the subject. (Leaflets showing the scheme adopted were here distributed to members.) The object of the scheme was not merely to make science a means of education, but an integral part of the education of the pupils. He also made a point of keeping the lecture experiments up to date.—Mr. Rentoul said dynamics should not be taught as a mathematical subject, but experimentally. He thought it of the first importance that boys should learn how to find out facts for themselves, and for this practical work was essential.—Prof. Ayrton remarked that the conditions under which science was taught differed in different places. He himself taught with the object of enabling the persons under instruction to improve the industry. For this purpose he believed the analytical method more suitable than the synthetical one advocated by Mr. Sanderson. It also had the advantage of being more scientific, for it was more natural, being, in fact, that used by children from birth, for they had no other means of learning the nature and properties of their surroundings. In his first year's technical course the work was synthetical, whilst in the third year the students, having analysed existing apparatus, were taught to devise new or improved forms, and hence the work became more synthetical.—Mr. F. J. Smith said it was important that students be taught to measure by the balance, micrometer, spherometer, and as soon as possible. He also inquired how far Mr. Sanderson's pupils could help themselves in making the apparatus required for the simple experiments.—Dr. Gladstone agreed with many points in the paper. Lately he had had to do with schemes for improving the teaching in elementary schools. Children were naturally philosophers, but at present their curiosity was considered objectionable and sternly repressed. Efforts were now being made to alter this state of things. Kindergarten classes in infant schools were a step in the right direction. It was very difficult to introduce analogous methods in the higher standards, but natural science had now obtained a footing. Although the methods of teaching adopted might be those suitable for pure science, care should be taken to put in practical illustrations, for when suitably chosen they are sources of great interest to children.—Mr. Sanderson, in reply, said the slide rule was used throughout the course. Mechanics was taught by actual machines, such as pulley blocks, screw jacks, &c. The boys made some apparatus, but to make all would require too much time.—The President, when proposing a vote of thanks to the author of the paper, said that in Ireland the opinion that boys and girls cannot be taught science greatly predominated. They found considerable difficulty in getting any continuation of the kindergarten teaching sanctioned. Possibly drawing might be allowed, but this seemed all they could hope for at present. He wished to emphasise the fact that in such schools the object was education, and practical applications of science were not important except in so far as it created an interest in the subjects. At present scientific teaching was in an experimental stage, and as in other things, progress is made by trial and error. Many different methods were being tried, and it was important to know which were successful and which failures. He thought the Physical Society might be useful in collecting information on the subject by issuing a circular of questions to science teachers, and subsequently drawing up a report on the subject.

Royal Microscopical Society, December 21.—Dr. R. Braithwaite, President, in the chair.—After the formal business necessary to be done at the meeting preceding the annual meeting, the Society adjourned as a mark of respect to the lately deceased Sir Richard Owen, K.C.B., the first president of the Society.

January 18.—Dr. R. Braithwaite, President, in the chair.—This being the annual meeting the President gave an address on the development of mosses and sphagnums, illustrating his subject with drawings and slides under microscopes in the room.—On the Rev. Canon Carr proposing, and Mr. W. T. Suffolk seconding, a hearty vote of thanks was given to the President for his interesting address.—The annual report and the treasurer's statement of accounts having been read and adopted, the following were elected as officers and council for the ensuing year:—President: Mr. A. D. Michael; Vice-Presidents: Dr. R. Braithwaite, Mr. F. Crisp, Mr. James Glaisher, and Prof. Charles Stewart; Treasurer: Mr. W. T. Suffolk; Secretaries: Prof. F. Jeffrey Bell, Dr. W. H. Dallinger; Ordinary Members: Dr. Lionel S. Beale, Mr. A. W. Bennett, Rev. Canon Carr, Mr. E. Dadswell, Mr. C. Haughton Gill, Dr. R. G. Hebb, Mr. G. C. Karop, Mr. E. M. Nelson, Mr. T. H. Powell, Prof. Urban Pritchard, Mr. F. H. Ward, and Mr. T. Charters White.

OXFORD.

University Junior Scientific Club, February 1.—The President in the chair.—At the conclusion of private business Mr. J. E. Marsh gave an exhibit of some products of the electric furnace. He had brought for the inspection of the club some specimens, from M. Moissan's laboratory, of fused lime and uranium reduced from the oxide. He explained the construction of the furnace, and the methods of using it and of obtaining the temperature of the arc. He further commented on M. Berthelot's views as to the limit of temperature of the furnace, pointing out that the maximum value was that of the temperature of vaporisation of carbon, and that in all cases this was obtained. After a short discussion Mr. F. Finn, who has just returned from Africa on a worm-hunting expedition, described the incidents of his journey. His remarks were illustrated by a number of lantern slides showing scenes on the coast, chiefly at Mombasa and Zanzibar. His first stay was at Lamu, where he did not get any worms, the natives misunderstanding his signs and bringing bones. He described his impressions of Zanzibar at some

length, being agreeably surprised at the place. Near here he obtained several reptiles and birds which are now in the Zoological Gardens. His chief collection was made at Mombasa, however. He speaks very highly of the hospitality of the Europeans on that coast.—Mr. F. G. Fremantle read a paper on Hermaphroditism, confining his attention to human beings. He divided his subject into various classes, ranging from complete, or almost complete, neutrality of sex, to those cases where either male or female characteristics preponderated, concluding with some cases of pure deception. The paper was illustrated with diagrams, and a large number of cases were cited in support of the statements made. He showed that a perfect hermaphrodite both physiologically and anatomically could not exist, either the male or female characters preponderating in every case. After a short discussion the club adjourned until February 17.

CAMBRIDGE.

Philosophical Society, January 30.—Prof. T. McK. Hughes, President, in the Chair.—Mr. Bateson exhibited a dog's skull, lent by Mr. J. Harrison of Northampton, in which the upper canines were bigeminous, each having two crowns both in the plane of the arcade.—The following communications were made:—On a new fern from the coal measures, by Mr. A. C. Seward. The specimen described as a new species, *Rachiopteris Williamsoni*, resembles in certain particulars the genus *Myeloxylon*, but possesses distinctive characters not previously recognised in fossil fern petioles. *Rachiopteris Williamsoni* may be briefly described as a petiole with scattered vascular bundles; those near the periphery appear to be rather collateral than concentric in structure, but the larger bundles have a more decided concentric arrangement of the xylem and phloem. Each group of xylem elements is surrounded by a ring of small secretory canals. The hypoderm is like that of *Myeloxylon*, and gum (?) canals are abundantly distributed in the ground tissue. On the intestinal movements of *Daphnia*, by Mr. W. B. Hardy. — On Urobilin, by A. Eichholz, Emmanuel College. In this communication a new method of urobilin extraction was described, by which the pigment is preserved in the state of chromogen. The properties of urobilin in normal and febrile urines were recapitulated in order to compare urobilin with the reduction products from bilirubin and hæmatin. The communication was then devoted to a description of experiments devised to settle the question as to the possibility of artificial production of urobilin from bilirubin and hæmatin. After pointing out how Maly's hydrobilirubin differs from true urobilin, and how consequently the identity of Hoppe Seyler's and Neucki and Sieber's urobilin from hæmatin reduction becomes doubtful, it was shown, in spite of statements to the contrary by McMunn and Le Nobel, that it is possible by complete reduction of both bilirubin and hæmatin to obtain substances in each case accurately resembling urobilin.

PARIS.

Academy of Sciences, January 30.—M. de Lacaze-Duthiers in the chair.—On some objects made of copper of a very ancient date, discovered in the course of M. Sarzec's excavations in Chaldæa, by M. Berthelot. M. de Sarzec has unearthed some relics of the most ancient Chaldæan civilisation, which confirm M. Berthelot's views as to the existence of an age during which pure copper was used instead of bronze, the latter being introduced after the rise of the commerce in tin. A fragment of a small votive figure, found among the foundations of an edifice more ancient than that of the King Our-Nina, was assayed for copper and chlorine by means of nitric acid. It contained neither silver, bismuth, tin, antimony, zinc, nor magnesium; only traces of lead, arsenic, and sulphur, and 77·7 per cent. of copper, the bulk of the rest consisting of alkaline earthy carbonates and silica. Its composition resembles that of the statuette of the Chaldæan King Goudeah, and also that of the sceptre of the Egyptian King Pepi I., of the sixth dynasty, showing that in those early times tin was not known in the two most ancient homes of civilisation.—On the diurnal variations of gravitation, by M. Mascart. A barometric tube enclosing a column of mercury 4·5m. in length, balanced by the pressure of hydrogen contained in a lateral vessel, has been kept surrounded by earth for several years at the Parc Saint-Maur Observatory, only the short upper end emerging from the ground. A study of the daily motions of the column by means of photographic registration has recently, apart from the slow and steady changes due to inevitable differences of temperature, shown sudden variations lasting from 15 to 60 minutes, which can hardly be explained otherwise than as due to corresponding variations in gravitation. They have been as high as 1/20 mm., or 1/90000. The differences of sea-level from high to low water would only produce 1/5th of this variation. The phenomena, if due to subterranean displacements, would be specially interesting in volcanic districts.—On solar statistics for the year 1892, by M. Rod. Wolf.—On the pathogenic properties of the soluble substances formed by the microbe of contagious bovine peripneumonia, and their value for the diagnosis of the chronic forms of this disease, by M. S. Arloing.—The H and K lines in the spectrum of the solar faculæ, by Mr. George E. Hale.—On the differential equations of a higher order, the integral of which only admits of a given number of determinations, by M. Paul Painlevé.—On ordinary linear differential equations, by M. Jules Cels.—On the systems of linear differential equations of the first order, by M. Helge von Koch.—On the theory of spherical functions, by M. E. Beltrami.—Decomposition of alkaline aluminates in presence of aluminium, by M. A. Ditte.—Electrometric study of acid triplatohexanitrite of potassium, by M. M. Vèzes.—Action of water vapour upon perchloride of iron, by M. G. Rousseau.—On two combinations of cuprous cyanide with alkaline cyanides, by M. E. Fleurent.—On the composition of some hydrated alkaline phenates, by M. de Forcrand.—Researches on the acid salts and the constitution of the colouring matters in the rosaniline group, by M. A. Rosenstiehl.—Analysis of medicinal creosotes; gayacol, by MM. A. Béhal and E. Choay.—On an apparatus for the quantitative determination of precipitates by an optical method, by M. E. Aglot.—On the pre-existence of gluten in wheat, by M. Balland.—The evolution of the intestinal gregarinas of the marine worms, by M. Louis Léger.—Origin and multiplication of Ephestia Kuehniella (Zeller) in the mills of France.—On the perithecæ of *Uncinula spiralis* in France and the identity of the American and European *Oidium*, by M. G. Couderc.—Histological researches on the *Uredinei*, by MM. P. A. Dangeard and Sapin-Trouffy.—New geological observations in the French Alps, by M. W. Kilian.

CONTENTS.

THURSDAY, FEBRUARY 16, 1893.

QUALITATIVE CHEMICAL ANALYSIS.

Qualitative Analysis Tables and the Reactions of certain Organic Substances. By E. A. Letts, D.Sc., Ph.D., F.R.S.E., F.C.S., &c. (Belfast: Mayne and Boyd, 1892.)

THE author in his preface says, "Every teacher has his own methods—acquired not only from his experience, but also largely through the researches of others—and this book embodies mine." Therefore the volume cannot fail to be welcome to those who take an interest in the teaching of analytical chemistry. But it is surprising to find that Prof. Letts has until quite recently followed the old method of dictating reactions and methods to his students, and allowing them to work from their own notes. For the last fifteen years there has been no lack of text-books of qualitative analysis, and Prof. Letts has found, what probably all teachers of the subject are aware of, that students rarely take accurate notes. But, however exact they may be, every one knows that manuscript is not so easily deciphered nor so readily referred to as a printed page.

The methods of work given are, of course, more or less on the ordinary lines. The final test for bismuth depends upon the production of its black suboxide, and this reaction has much to recommend it, though probably many would prefer the oxychloride reaction. The use of ammonium molybdate as a separative reagent in qualitative analysis we do not consider advisable for many reasons, but no complaint can be lodged against it on the score of its accuracy.

There can be no doubt whatever that both Prof. Letts and his students will find considerable advantage in the use of boldly-printed statements of methods. But the author begins his preface by stating that although the book has been written chiefly for his own students, he will be glad if it prove of service to others also. This lays the volume open to general criticism, and prompts us to complain that it is neither so clear nor so systematic as it might have been. As to the want of clearness, there are a few expressions that can easily be altered in a second edition, and these we lay no particular stress upon. For example, at page 27, in the description of Bunsen's dry tests, we read :—"The charred end of the match is next moistened with fused carbonate of soda." At page 40 it states that the solution "is mixed with its own volume of chloride of ammonium." One assumes this to be a solution, but if so the strength of it is not given, and we fear that the bulk of the solution to which it is to be added will be likely to vary enormously according to the peculiarities of the student and the character of the substance he is at work upon.

The more important want of clearness may be exemplified by taking the case of a student who has Epsom salts given to him as a simple salt. This can hardly be called an out-of-the-way substance, but so far as we can discover, the student in following these tables would examine it by the following series of operations: Heating on platinum wire to see the colour of the flame. Heating on a borax bead in the outer and inner flames. Heating on a carbonate of soda bead. Heating on charcoal (if a white mass resulted, which with cobalt nitrate gave a "faint pink," the metal might be recognised here, but as magnesium sulphate does not readily yield this reaction in most cases the student would pass on). Heating on charcoal with sodium carbonate. Heating in a glass tube closed at one end. Repeating with bisulphate of potash. Repeating with black flux. Repeating with magnesium wire. He would then dissolve the substance in water, and test a part of the solution for ammonia by heating it with caustic alkali. Then heat a part on a platinum wire for the flame colouration, a test that has already been done on the solid, and then pass on to the examination of the solution in the ordinary way for the base, and finally search for the acid if it is not already found. It may be taken for granted that this fiddling about with the substance is not intended, but the volume does not appear to contain directions as to how to go more directly to work.

The want of system that we complain of is acknowledged by the author himself in picking out certain parts and labelling them as "systematic." If the whole were systematic this distinction would obviously be meaningless. As this fault exists in many of the text-books and in much of the teaching that we have had experience of, we are tempted to make a few general remarks upon the matter without special reference to the volume under notice.

That qualitative analysis is often regarded as a very unimportant branch of chemistry, may account for its comparative neglect. One constantly meets with students who are able to perform quantitative operations of not too complex a character with commendable accuracy, and that can with a little guidance do many sorts of "research work," but are wholly unable to perform with certainty a qualitative analysis of a comparatively simple substance. They may happen to find most or all of its constituents, but they have no confidence in their result; they do not feel sure that they have missed nothing, or indeed that everything they have found is unmistakably present, and generally they have little if any idea of the degree of accuracy of their work. They cannot distinguish between a principal constituent and one that is present in a comparatively small proportion. This incompetency must be ascribed very largely to the fact that students are too often urged on to work that a casual observer might regard as more important. The foundation is neglected for the sake of the superstructure.

But having regard only to that amount of practice in qualitative work that still remains possible for the average student, there is too often a lack of method that is surprising if not disastrous. As a rule, it is considered desirable to get first an idea of the general character of the substance given for examination by a few dry tests, but these, as often done, are not only of no use, but serve in a conspicuous manner to train the student in the making of careless and imperfect observations, and in the dodging about from one operation to another with no idea of the proper sequence or inter-dependence of the various parts of the work. In the analytical examination of even the simplest of substances, from the

time when the student receives it until he has made his last note, every operation ought to be in an order for which very definite reasons can be given, and the completed work ought to be of such a character that anything added to it would be superfluous; anything taken from it would leave it imperfect; and any change in the order of its various parts would be to its detriment. This character of work is generally sought after in the separation of metals from a solution; but the rest of a qualitative analysis, namely the preliminary examination and the testing for acids, is too often a collection of odd operations, which, if the student is lucky, will lead him sooner or later to the desired result, but if he is unlucky may fail to do so through no fault of his own.

Chapman Jones.

POPULAR LECTURES ON PHYSICAL SUBJECTS.

Gemeinverständliche Vorträge aus dem Gebeite der Physic. Von Prof. Dr. Leonhard Sohncke. (Jena: Gustav Fischer.)

It is a matter of common remark that the books on scientific subjects which reach us from Germany are, as a rule, so special and detailed in character as to be totally devoid of interest, except to those immediately concerned with the subjects of which they treat. This being the case, it is all the more refreshing to meet with such a collection of popular addresses as Prof. Sohncke has gathered together in the volume before us. He has not restricted himself in his choice of subjects to any one branch of physics; on the contrary, the nine lectures of which the book is made up represent as many different divisions of natural philosophy, and were delivered quite independently before various audiences in Germany.

The first lecture of the series bears the somewhat obscure title, "What then?" and was suggested by a great strike among the coal-miners of Westphalia, which led to a temporary cessation of the German coal supply. The author depicts what would be the consequences if the world's coal supply were exhausted, in terms almost as pathetic as those of Prof. Jevons which moved an English Parliament to appoint a commission on the subject. But recognizing that, after all, coal is only stored up solar energy, Prof. Sohncke endeavours to look at the brighter side of the question by discussing the possibility of utilising the sun's energy in other forms, and so enabling man to remain "lord of creation" even in those days when the entire available coal supply of the world reposes on the shelves of some scientific museum.

Equally spontaneous is the lecture on "Migratory Mountains," in which an account of a holiday visit to the north-east corner of Germany gives an opportunity of describing the formation and movements of the mammoth sand-dunes in that locality.

Of the other lectures, that entitled "The revolution in our views concerning the nature of electrical actions" will probably commend itself to most readers because it treats of a subject now exciting general interest. It contains a short history of the arguments and experiments which led to the substitution of the ether theory of electrical action in the place of the older action-at-a-distance theories. While admitting the existence of a medium which transmits both optical and electrical disturbances, the author thinks it more probable that gravitation is a true action-at-a-distance, and in so doing he tacitly denies that a medium is a necessity. The notion of an empty space is so foreign to English men of science of this generation, that we certainly consider Prof. Sohncke's summing-up of the question to be worthy of attention. He says:—"Even if we could finally succeed in proving that action-at-a-distance is really the result of a transmission through some medium, we must not suppose that all difficulties are then removed. For the process of such a transmission is by no means simple, and cannot be explained without further assumptions; on the contrary, very formidable difficulties arise even here. Directly we try to give a concise explanation of the compression of a body and its subsequent expansion when performing elastic vibrations, we find that a choice must be made between two assumptions equally hard to accept. Either matter is itself capable of compression and expansion, or else it consists of separate vibrating atoms to which we must assign the property of exerting mutual forces on each other at a distance."

From a purely scientific standpoint, the lecture on "Newer theories of atmospheric electricity and thunderstorms" is undoubtedly the most valuable of the series, the subject being one on which Prof. Sohncke can speak with some authority. After describing the older theories of the origin of electrical charges in the atmosphere, he discusses those newer ones which were suggested by the discovery of Hertz that ultra-violet light facilitates the discharge of electricity from a charged body. Of these the best known is that of Arrhenius, who supposes the air, ordinarily a dielectric, to be rendered feebly-conducting by the action of light. According to this theory, the earth is negatively charged, and when its atmosphere is illuminated some of the charge is conducted away to the clouds. The conduction must be electrolytic, otherwise the air would become charged. Prof. Sohncke objects to this theory mainly on the ground that the discharging action of light cannot be considered as due to the air in any way, since it is manifested only when the light vibrations fall on, and are absorbed by, the negative electrode. Further, it is not easy to see how elementary gases such as oxygen and nitrogen can be electrolytes. In concluding he defends his own theory, according to which atmospheric electricity is produced when a cloud laden with particles of ice meets another charged with water drops, the electrification being due to the friction of ice against water. In support of his view the author quotes the fact that hailstones are found to be electrified on reaching the ground.

The appearance of a volume like the present one invariably gives rise to some regrets that the whole earth is no longer of one language and one speech, but we hope that some friend of popular science may be induced by the contents of the book to furnish a translation for English readers.

James L. Howard.

BRITISH JURASSIC GASTEROPODA.

A Catalogue of British Jurassic Gasteropoda, comprising the Genera and Species hitherto described, with references to their Geological Distribution and to the Localities in which they have been found. By W. H. Hudleston, M.A., F.R.S., P.G.S., and Edward Wilson, F.G.S. 8vo, pp. xxxiv+147. (London: Dulau and Co., 1892.)

NEXT in importance to a monograph on any group of fossils is a catalogue of the species giving their distribution, their synonymy, and references to the figures and descriptions. The value of such a catalogue is enormously increased when, as in the present case, the authors have made a prolonged and careful study of the subject. The late Prof. John Morris was able, with scarcely any help from other workers, to publish a critical catalogue of all British fossils; the first edition appeared in 1843, the second in 1854. But since that date so much progress has been made in palæontology that the accomplishment of such a task by any one man would now be an impossibility. Prof. Morris always hoped to bring out a third edition of his work, and after his death a committee was formed to carry out this project. But the labour appears to have been too great and the committee soon ceased to exist. This is greatly to be regretted, for although the work must of necessity have been distributed among various authors, a certain amount of uniformity in treatment would at any rate have been secured and publication hastened.

In the preface we are told that Mr. Hudleston is mainly responsible for the Oolites and Mr. Wilson for the Lias. Under the term Jurassic the authors include everything from the Lias to the Portland-stone: the Rhætic beds, although not regarded as strictly Jurassic, are treated in the supplement. The total number of gasteropods recorded by Samuel Woodward from these formations in 1830 was only 89, whereas in the present work the number given is 1015. Of these 15 come from the Rhætic, 314 from the Lias, 681 from the Oolites, and 5 from the Lias and Oolites. In the Lias the gasteropods are characterized by the species belonging to comparatively few genera. Although, as far as genera are concerned, the Lias shows considerable affinity to the Oolites, there is nevertheless a great break in the continuity of the species, only five being common to the Lias and Oolites. Gasteropods are most abundant in the calcareous beds, so that the Lower Oolites have yielded by far the larger number of forms, the Inferior Oolite being richer than the Great Oolite. In the Middle and Upper Oolites there is a decided decline in the gasteropods, especially of the argillaceous beds.

After the introductory remarks the authors give a valuable bibliography of the British Jurassic Gasterpoda, and then a list of the genera, in which each is placed in its proper family and reference given to the original description. By the use of different type the genera are divided into four classes, (1) those fully accepted by the authors, (2) those accepted with doubt, (3) those given as Jurassic by other authors but not accepted, (4) synonyms. In the catalogue proper the authors have adopted Morris's plan, each page being divided into two columns; in the larger are given the name of the species, the references, the synonyms, and the cross-references; in the smaller the geological horizon and the more important localities, the locality first named being that from which the type was obtained or the first place from which the species was recorded in Britain. The dates of publications are often omitted, but since they can be found in the bibliography this is not very inconvenient except in the case of serials. The present *locale* of types is not given, although this would have been a comparatively easy matter, especially since so many catalogues of types have been recently published.

With regard to the orthography the authors have kept to the older and more usual method. For instance, the capital initial is used for species when derived from proper names, and the single *i* for the genitive is not always adopted. Thus we find a considerable variation in the terminations, such as, *Cricki* (p. 124) *Crickii* (p. 77), *Waltoni* (p. 42) *Waltonii* (p. 139), *Suessea* (p. 29) *Suessii* (p. 138), *Wrightii* (p. 46) *Wrightianus* (p. 70). These are, however, purely matters of opinion and do not in any way detract from the great value of the work, which exhibits so much painstaking accuracy and sound criticism.

H. Woods.

OUR BOOK SHELF.

The Year-Book of the Imperial Institute of the United Kingdom, the Colonies, and India, and Statistical Record of the Resources and Trade of the Colonial and Indian Possessions of the British Empire. Compiled chiefly from official sources. First issue 1892. Issued under the authority of the Executive Council, and published by John Murray, &c. Large octavo pp. xvi. and 824.

THE Imperial Institute has lost no time in issuing a handsome and comprehensive year-book, compiled by the Librarian, Mr. J. R. FitzGerald, who has diligently and successfully gathered together a stack of varied information bearing on the purposes of the Institute. It is a question which time alone can answer whether amongst the many admirable year-books of statistics, commerce, and the colonies which have established themselves as annuals of proved utility, there is room for a new and bigger book overlapping their information, and containing few, if any, novel features. It would be out of place to discuss this question in a notice which ought to be confined to the scientific aspects of the work. The object of the year book, as expressed in the preface, is to deal "statistically with the physical geography, the natural resources, and the industries and commerce of the Colonies and India," and with certain other related facts. It would not be fair to criticise severely the first issue of so large and comprehensive a compilation; but it would help towards the attainment of the compiler's aim if the description of the physical geography of the regions touched upon could be made as full as the historical introductions, and as statistical as the commercial tables. More notice ought to be taken of the geology and the character of the soil in the colonies where geological surveys are in progress; and climate certainly deserves better treatment. We do not think space would be wasted in giving the mean monthly temperatures and rainfall for the average year, and for two extreme years, at a few representative stations in the larger colonies. This information cannot indeed be found in any existing books, but must be worked out from original records which exist abundantly, and are rarely made available to practical workers.

The treatment of natural resources might also be

improved by a firmer grasp of scientific principles. The commercial statistics are, as might be expected, much fuller, better arranged, and more serviceable than those relating to physical geography; but we imagine that few members of the Imperial Institute, likely to make use of the book, are without the original records relating to their own department. The difficulty of proportion and perspective is rather seriously apparent in the treatment of India, which has to be passed over more lightly than the colonies, because equal detail would involve the sacrifice of much space. Thus the great internal trade of India is scarcely touched upon, and the wants and tastes of consumers in the ultimate Indian market, by whom imports are finally absorbed, are not laid before the British merchant.

Beneath Helvellyn's Shade. By Samuel Barber. (London: Elliot Stock, 1892.)

THIS book consists of notes and sketches in the Valley of Wythburn, and is brightly and attractively written. Perhaps the best chapters are those on clouds, the various forms of which have been carefully studied by the author. He has also many interesting remarks on various aspects of Cumberland scenery, on the customs of the people, and on antiquities. Occasionally, perhaps, Mr. Barber adopts too much the tone of a preacher, but his impressions and ideas are for the most part fresh and vivid. The book will especially please those who have themselves felt the charm of Wordsworth's country.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Dr. Joule's Thermometers.

RESPECTING the question asked by Mr. Young (NATURE, vol. xlvii. p. 317), I am glad to have an opportunity of stating that shortly after Joule's death I obtained the sanction of his son to examine the scientific apparatus that were left in his house.

I found a number of thermometers, and amongst them the two chiefly used by Joule in his researches. These thermometers have been placed in my charge for the present. I have made careful comparisons of them with a standard of the "Bureau international des Poids et Mesures," and therefore indirectly with the air or hydrogen thermometer. A standard issued by the Technische Reichsanstalt has also been used as a check. I spent a good part of last winter on the work and am now only waiting for an opportunity to repeat some of the measurements. The results will be published in due course, and I think will prove of interest. As Joule compared his thermometers with one used by Rowland, we shall in this way have an indirect comparison of Rowland's air thermometer with those by which the Berlin and Paris standards have been independently fixed.

One question arises on which I should be glad to have some information, and I should be grateful to any of your readers who could help me. The glass of which Joule's thermometer is made does not behave like the English glass now in use; and it would be important to know the probable composition of glass used in England about the year 1840 for thermometric purposes. As my experiments are not concluded I do not wish to speak with too great a certainty; but I believe it will be found that if we could return to the glass of Joule's thermometer, we should have a substance as well and possibly even better adapted to the manufacture of thermometers than the modern Jena or French thermometer glass.

I am sorry I cannot give a very definite answer to Mr. Young's question. Joule does not, as far as I know, anywhere give the actual readings of the freezing point, but only its changes. Rowland, in quoting the comparison between Joule's thermometer and his own, gives 22·62 as the actual reading of Joule's zero. I have not at the present moment access to Rowland's paper, and have no note of the date at which this comparison was made (either 1879 or 1880).

Such a formula as that given by Mr. Young can, however, only have a limited application. The zero of a thermometer depends on the temperature at which the thermometer has been kept previous to its immersion into ice, and with properly-annealed thermometers the secular changes are much smaller than the temporary ones. Last winter Joule's thermometer showed changes in zero from 23·51 to 23·00 on the arbitrary scale, the original temperatures varying from 7° to 30°.

All observations lead to the conclusion that the secular changes of a thermometer gradually vanish, so that the zero corresponding to any temperature approaches a limit. Mr. Young's formula would make the zero rise indefinitely.

ARTHUR SCHUSTER.

Dust Photographs and Breath Figures.

YOUR two correspondents on February 9 add interesting instances of these phenomena. I am sorry that one of my statements was not clear. In saying "Two cases have been reported to me where blinds with embossed letters have left a latent image on the window *near* which they lay," I meant to describe them as not in contact.

I have questioned my neighbour Dr. Earle again as to his case. The plate-glass window of an hotel in London has on the inside a screen of ground glass lying near but not touching: upon the latter are the words "Coffee Room" in clear unfrosted letters. One day as he was at breakfast the screen was taken away, but the words were left plainly visible on the window, and no washing would remove them. The other case is curiously similar, but each narrator was ignorant of the other's tale. A friend, Mr. Potter, asked me if I knew whether a house in which he was lodging had been an hotel, for on misty days they saw "Coffee Room" on one of the windows. I remembered the house had been an hotel two or three years previously, and there had been brown gauze blinds with gilt letters.

Mr. Thiselton-Dyer's observation appears not so much akin to these two as to the dust picture of a water-colour drawing of which I spoke in my former paper.

I look forward to seeing the effects at Canterbury.

Winchester College, February 13. W. B. CROFT.

Fossil Plants as Tests of Climate.

MR. DE RANCE'S note relating to the above subject in NATURE, p. 294, mentions that "Heer has determined a magnificent flora of more than 350 species from these northern tertiaries, and that he at once pointed out the absence of tropical and subtropical forms." My contention, founded on an attentive study of his determinations and of the original specimens in London and Dublin, and to some extent in Copenhagen, is that not fifty, or perhaps not the half of fifty, of these determinations are entitled to the smallest weight; and again that though at first he saw nothing subtropical in the flora, he subsequently declared the presence of palms, &c., upon utterly insufficient data. While, however, wishing to rid the "magnificent" flora of 300 or more useless and misleading encumbrances, I am far from wishing to depreciate the extraordinary significance and value of that which remains, and which clearly shows that in early Eocene times the coast of Greenland supported in certain places forests which included the redwood, the plane, and even the magnolia, associated with many more northern forms. This is consistent with the tropical vegetation existing during a part of the possibly contemporary lower tertiary period in the south of England. Both facts are sufficiently inexplicable, but there is no occasion to magnify the difficulties they present. As to the Greenland floras they have not been proved to contain any forest trees that might not, and which in fact do not, flourish in their modern representatives, when planted in certain favourable spots on the west coast of Ireland, and even of Scotland. We are not even obliged to assume that Greenland as a country was characterised by such vegetation, for this might be as erroneous as to regard Ireland or Scotland as countries generally characterised by forests of arbutus. The flora of a country is in fact most likely to be preserved in its most sheltered spots, in lake bottoms like parts of Killarney, or where small rivers quietly steal into the tidal waters of deeply recessed bays like those of Bantry and Kenmare, in forest pools like some in the Mount Stewarts' woods of Bute, and

in the backwaters and marginal pools of the lower reaches of larger rivers; we are not only entitled, but we are bound to consider this to have been the case in Greenland, and to base our estimate of its climate in the lower tertiaries upon this view and no other. Now what geologists and physicists ought to do, and what they resolutely won't do, is before going farther afield for cause and effect, to take the map of the world on Mercator's projection, and consider how far, if the Atlantic were a closed ocean to the north, as we know it must have been, the required climatic conditions would be produced. The difference between the arbutus nooks of Ireland on the one side and the desolation of Labrador on the other is brought about solely by ocean currents. At the period of the Greenland floras the arctic currents were excluded, and consequently the whole Atlantic basin was filled with the circulation of equatorial and temperate waters only. The distribution of plants and animals renders it extremely probable that during much of the tertiary period, the antarctic waters were equally excluded from the Atlantic by land connecting Africa and South America. What, under these circumstances, would happen to the climate of the Atlantic littoral? It would, it appears to me, be more philosophical to dispose of this question, which is supported by a weight of evidence, before invoking shifting of the earth's axis, or other hypothetical causes supported by none. J. Starkie Gardner.

London, February 13.

An Optical Phenomenon.

In Nature, vol. xlvii. p. 303, you mention that "a beautiful optical phenomenon, which has not yet been satisfactorily explained, is described by M. F. Folie in the *Bulletin* of the Belgian Academy." From what follows, it is evidently the same as that described in Tyndall's "Glaciers of the Alps" (Murray, 1860), p. 177 *et seq.* Tyndall gives a description of it in a letter from Prof. Necker to Sir David Brewster, from which I quote the following:—"You must conceive the observer placed at the foot of a hill between him and the place where the sun is rising, and thus entirely in the shade; the upper margin of the mountain is covered with woods, or detached trees and shrubs, which are projected as dark objects on a very bright and clear sky, except at the very place where the sun is just going to rise; for there all the trees and shrubs bordering the margin are of a pure and brilliant white, appearing extremely bright and luminous, although projected on a most brilliant and luminous sky. You would fancy you saw these trees made of the purest silver."

Prof. Necker says that he saw it at the Saleve, which is not so high above the Lake of Geneva as some of our British mountains above the sea, and has no permanent snow near it; so that M. Folie's suggestion, that it is due to light reflected from snow, must be wrong. I have seen it from the König-See, near which I believe there is no permanent snow.

This appearance is always to be seen under the circumstances described, when the sky is clear and bright enough. I had read of it in Tyndall's book, and when in the Alps I sought for and found it. I have often seen a distant approach to it produced by furze bushes, quite near, seen against sunlight, and by leaves against moonlight. Joseph John Murphy.

P.S.—Ruskin somewhere describes this phenomenon.

Belfast, February 6.

Foraminifer or Sponge?

A paper by A. Goës "On a peculiar type of Arenaceous Foraminifer from the American tropical Pacific, *Neusina Agassizi*," has just been published in the "Bulletin of the Museum of Comp. Zoology, at Harvard College," vol. xxiii. No. 5, in which the author describes some remarkable forms dredged by the *Albatross* expedition in the Pacific of Central America. They are supposed to be foraminifera, are of leaf-like shape, measure up to 190 mm. in breadth, and are marked by concentric lines of growth. Their interior shows a stroma, consisting of fine chitinous threads, enclosing sand and *débris* of shells. Without wishing to recapitulate all the various points of structure, I will only say that there can be no doubt that these forms belong to Hæckel's deep sea keratosa (see *Challenger* report, vol. xxxii.) from the tropical Pacific, and I should think that *Neusina Agassizi* is identical with *Stannophyllum zonarium*, Hæckel. I happen to have here a *Challenger* specimen of this latter species, kindly lent to me by the Manchester Museum, and its microscopic examination convinces me of the identity of the two forms.

University College, Liverpool. R. Hanitsch.

Unusual Origin of Arteries in the Rabbit.

Towards the close of last month Prof. W. N. Parker reported in your columns an abnormality in the veins of the rabbit, and although the same interest does not attach to it, it may be worth while recording an unusual arrangement of the vessels arising from the aortic arch. In the case which has just come under my notice, the two carotids arise together from the arch, at the point usually occupied by the innominate artery, while the right subclavian artery arises beside the left subclavian, which occupies the usual position. Philip J. White.

University College of North Wales, February 7.

Holmes's Comet.

On February 11, 10h. to 10h. 35m., I re-observed this object with powers of 40 and 60 on my newly-silvered 10-inch reflector. The comet was in the same field as β Trianguli and south preceding that star. I found it fairly conspicuous. The nucleus, or brighter portion of the head, presented a distinctly granulated appearance. Applying a power of 145, single lens, I saw that it really consisted of a number of very small knots of nebulosity, so closely approximating the stellar form that they might readily have been mistaken for one of the very faint, barely resolvable clusters in which the components are only to be caught by glimpses. The multiple nucleus was involved and surrounded with feeble nebulosity, and a faint tapering tail flowed from it in a N.E. direction. I believe that outlying this there was an excessively faint fan-shaped tail, but could not be absolutely certain.

The sky was not good, being lighter than usual, with suffused mist. On February 12, at 10h. 15m., I picked up the comet again, but details were invisible, owing to the veil of thin cloud overspreading the N.W. sky at the time.

Bristol, February 13. W. F. Denning.

HELMHOLTZ ON HERING'S THEORY OF COLOUR.

The following translation of the critical account given by von Helmholtz of the colour-theory of E. Hering, in the new edition of his *Handbuch der Physiologischen Optik*, commencing at page 376, has been made by Prof. Everett for Nature. The translator aims at clearness rather than literal rendering, and three obvious misprints in the paragraph on the transformation of coordinates have been corrected. "Lambert's colour-pyramid" is another name for the "cone of colour" described in Maxwell's papers and in § 1074 of Everett's "Deschanel."

This much-talked-of theory is a modification of Young's theory, which, by the choice of other fundamental sensations, endeavours to give better explanations of what it regards as immediate facts of internal observation. It assumes three elementary sensations, related to three different parts of the nerve-apparatus or "visual substance." Two at least of these physiological processes exhibit the opposition of positive and negative. One of the three "visual substances" gives in the condition of excitement the sensation of white, and in the condition of rest the sensation of black. The second gives the two sensations of blue and yellow, which are accordingly designated "opposed colour-sensations." The third gives the other pair of "opposed colour-sensations," red and green. But by "red" is denoted not the colour usually so called, but the complementary of green, which is purple.

It is possible to specify "elementary sensations" (in the sense in which we have previously defined the term) which would correspond to Hering's elementary sensations, and would be capable of giving by their combination all other colour-sensations. If we take three rectangular axes of coordinates, x, y, z, as the edges of Lambert's colour-pyramid, x corresponding to red, y to green, and

z to violet, Hering's coordinates u, v, w will have the values

$$u = \frac{x + y + z}{\sqrt{3}}, \quad v = \frac{x - z}{\sqrt{2}}, \quad w = \frac{x - 2y + z}{\sqrt{6}}$$

u denoting the white element, and being measured along the axis of the pyramid; w denoting the red-green element, and being measured at right angles to the axis of white, in the plane containing the green edge of the pyramid; v denoting the yellow-blue element, and being measured at right angles to the plane of u, w.

Positive values of w correspond to purple red, and negative values to green. Positive values of v correspond to yellow, and negative values to blue.

I give these equations in this definite shape for the purpose of showing, by a definite system of representation, that the arbitrariness which attends the choice of three colours, in terms of which the rest are to be specified, affords sufficient latitude to admit of the employment of three such different specifying elements as are adopted by Hering.

If only positive values of x, y, z are to be admissible, the expression for u shows that every kind of light must excite the white sensation positively, and consequently that no kind of objective light can produce a pure sensation either of the red-green or of the yellow-blue kind. Hence the pure unmixed "opposed colour-sensations" are such as we never have had or can have, and are separated from all colour-sensations that we have ever had by a much wider gap than the pure sensations which Young's theory supposes, although these latter extend somewhat beyond the range of objective colours. By subjecting portions of the retina to special influences (as we shall explain in treating of after-images) we can at least approximate to Young's elementary sensations; while these same methods, when we attempt to approximate to Hering's pure sensations, give results opposite to what his theory would lead us to expect.

Hering assumes, in accordance with the brief expression of his theory in the above equations, that white light excites only the white-black visual substance and excites it always positively; that yellow light, besides doing this, excites the blue-yellow visual substance, as does also blue light, but in opposite sense. On the other hand, when blue and yellow lights are in exact equilibrium, they have no action on the blue-yellow visual substance.[1] Similar remarks apply to the excitements of the red-green visual substance by red and green light.

The sensation of luminosity is identified by Hering with the sensation of white. He accordingly maintains that the pure sensation of blue or of yellow involves no sensation of luminosity. I must confess that personally I can form no conception of a colour which has no degree of less or greater luminosity, and therefore think such an abstraction not tolerable in a system which, on other points, makes its appeal to the immediate testimony of inner consciousness, and claims by this means to establish its superiority to other systems.

Differences of intensity must, however, occur in the opposed colour-sensations if they involve no difference of brightness. In comparing saturated blue with equally luminous pale blue, Hering would regard the white sensation as equally intense in both, but the blue sensation as stronger in the saturated blue.

As the physiological basis of the "opposed colour-sensations" Hering takes the two opposite processes of organic change, namely, the decomposition of the organic mass by activity, and its restoration under the influence of the circulation of the blood, which carries oxygen stored up in it and feebly united with it. The former process is called *dissimilation*, and the latter *assimilation*. Which of the two opposed sensations corresponds to dissimilation and which to assimilation is left undecided, both in the case of blue-yellow and of red-green. The physiological improbabilities of this assumption have in part been pointed out already, and we shall return to the subject in treating of after-images.

This assumption of double nerve-working was originally applied by Hering to the white-black visual substance also. At the present time he adheres to the hitherto-received doctrines of nerve-physiology to the extent of holding that, in the case of this substance, all light excites only dissimilation and the sensation of white; and on the other hand want of light produces only assimilation and restoration of excitability. That during this latter process a sensation of darkness is experienced, all are agreed. The difference is purely theoretical. According to the older view, which I have defended, we must, in order to perceive that there is luminosity in a particular part of the field of view at a given time, be able to distinguish at another time that this perception is wanting. This perception that a sensation which might be there is not there contains in itself a testimony as to the condition of the organ at the time, which is different from all sensations of incident light; and in this sense we call it also a sensation—the sensation of darkness.

Hering, on the contrary, maintains that the sensation of black must have its own special physiological basis of excitation, and seeks it in assimilation, going on in the white-black visual substance.

From the foregoing account the reader will gather that Hering's theory, if we overlook its physiological views, is able to explain all hitherto established facts of colour mixture as well as, but not better than, Young's theory. It differs only in its special choice of elementary excitations; and this choice, if we admit negative values of them, suffices for expressing the facts, just as any axes of co-ordinates suffice for a problem of solid geometry.

Hering's objections to Young's theory reduce themselves, in his latest statement, to the following:—

"In the Young-Helmholtz theory, the assumption of the three elementary colour-sensations is *à priori* repulsive, because these sensations are not presentable; and notoriously, according to necessity, now one set and now another set of elementary colour-sensations are assumed."

As to this, I have already remarked that the fundamental sensations of Young's theory, in so far as they differ from objective colours, can be approximated to, by the method of partial fatigue of the retina, much more closely than Hering's pure opposed-colour-sensations. If different upholders of Young's theory have made different assumptions as to the three primary colours, and have assigned different weights to various facts which bear on the distinction, this affords no justification whatever for the imputation that they have changed their assumptions according to necessity. It is always better to acknowledge existing doubt than to dogmatise.

Hering goes on, "If the excitations belonging to the three elements have correspondingly distinct physiological causes, one would expect that these sensations would have something special about them."

This they have, in my opinion, in the prominent glow of colour-saturation; for which, again, the theory of opposed-colours furnishes no basis of explanation.

He continues, "Yellow gives, for example, much more the impression of a simple or elementary sensation than violet, and yet we are told that the latter is an elementary sensation and the former a mixture of simultaneous sensations of red and green, or at least, in some way, the product of the simultaneous existence of the principal excitations corresponding to these two elementary sensations."

What a deceitful test apparent inner consciousness is in such matters, we can see from the examples of two

[1] This was a point which Hering left doubtful in the earlier statements of his system, so that it was not clear whether he assumed three or six independent variables. According to his more recent explanations the statement given in the text may fairly be said to represent his view.

such authorities as Goethe and Brewster, both of whom believed that they saw in green the blue and yellow, of which, being misled by experience with pigments, they believed it to be composed.

He goes on, "Helmholtz says, quite correctly, 'so far as I see, no way has been found of determining one of the elementary colours except the investigation of colour blindness.' This investigation has notoriously not confirmed Young's theory."

This would, even if it were true, be in itself no argument against the admissibility of the theory. The theory of colour-blindness seems, as we shall shortly see, to be a particularly hard crux for Hering's theory; while the hitherto well-established facts of red-blindness and green-blindness admit of comparatively easy and perfect explanation by Young's theory.

He adds, "And the three sets of fibres, which, however, as Helmholtz remarks, are not essential to the theory, have hitherto been sought for in vain."

This objection applies to Hering's theory as much as to Young's.

The reader will easily convince himself that these objections are of no weight whatever. He follows them up by an enumeration of contradictions and inaccuracies which he professes to have found in Grassmann's and my own explanation of Newton's law of colour-mixture, and partly also in that of Kries, errors which, even if they existed, would in no way tell against Young's theory, but only against its interpreters. Here, however, the obscurity seems to me to lie on the side of our opponent.

These objections arise out of the fact that, in mixtures of a saturated colour with white, the tint of the mixture sometimes seems changed (pale red for example approaches more to rose, and pale blue to violet); and that, on the other hand, with increase of intensity, the colours of the spectrum appear sometimes paler, sometimes yellower. But if we speak of those elementary excitations which, from the point of view of Newton's law, are alone entitled with certainty to the name of elements, as being able to coexist without mutual disturbance, then the only sensation which can with certainty be regarded as corresponding to the coexistence of a white and a red elementary sensation is that which comes into existence under the simultaneous influence of the corresponding white and red lights. The term "elementary sensation" is in this connection to be taken, of course, not in the narrow sense of Young's hypothesis, but in the wider sense above explained—the sense in which we speak of linear relations between colour-sensations and linear superposition of elementary-sensations. In the domain of colour-mixture we know nothing of any elements but these superposable ones; and if we would preserve a constant meaning for our colour-equations we must interpret them in this sense, as I have explained above. This is what H. Grassmann and myself have always done.

Moreover, erroneous estimates of the difference between a pale and a more saturated colour are liable to be made, and hence those colours which are really most diluted with white do not always appear the palest. If, without sufficient experience of colour-mixture, we only guide our judgments by similarity of sensations, we are liable to make mistakes as to which colour contains white. The question of the power of perceiving differences will therefore arise. Further, it is found that colours of very strong luminosity do not differ so much from one another in the sensations they produce as colours of moderate luminosity,—a fact which finds its explanation in Young's theory, of which it is a natural consequence. Colours when highly luminous appear more similar to one another and more similar to white. We express this by calling them pale as compared with colours of feebler luminosity. I have, however, already mentioned that the law of superposability ceases to be applicable when the luminosity is excessive.

Nevertheless, in view of the fact that simple colours of high luminosity are always as saturated as colours of such luminosity can be, it is not necessary, or rather it is not correct, to designate them as less saturated. The true statement is that differences of tint become more uncertain at high intensity—an uncertainty which attaches also to the estimation of the intensity itself, as has long been known.

If Hering's sensation of white and opposed-colour-sensations are truly to deserve the name of elements or constituent parts of sensation (as he plainly intends, since he assigns to them special visual-substances), either he must acknowledge them as the elements deducible from the law of addition, or else they are purely hypothetical processes of whose existence and superposability no one knows anything. His polemic against Grassmann and me then amounts to this—that at a time when his hypothesis had not been propounded we did not speak in the sense of it.

Hering seems to regard as the chief point of superiority of his own hypothesis its closer conformity with the names which have established themselves in language—names which, as I have explained above, relate rather to the colours of material bodies than to the colours of light. To this circumstance it is, in fact, indebted for a certain amount of popularity and facility of apprehension. He himself assumes that these names have sprung from an immediate perception of the simple elements of sensation by a kind of inner consciousness, and thinks that he has thus very certain and immediate knowledge of the pure red-sensation, the pure white-sensation, and so on.

In his publication of 1887 he has discussed the possibility of assuming, instead of three or six simple processes of sensation, a larger and perhaps indefinitely great number, and a corresponding number of "elementary powers" for the several kinds of objective light. He, however, gives the geometrical representations of such actions in such a manner that practically these powers all depend on three independent variables. On the other hand, as regards these independent variables, which are the most important factors in the problem, he gives as good as no clue to them; he only seeks to remove them as far as possible from the sphere of physiology. For my own part I am able to understand this whole series of descriptions only as meaning that an arbitrary number of visual substances can be assumed to exist in the brain, and that their respective strengths of excitation are different functions of the same three independent variables, each visual substance being unaffected by the excitations of the rest, and the excitation of each being susceptible of direct apprehension in consciousness. I do not think it is necessary, in this book, to go further into such hypothetical views.

Hering especially claims the credit of opening up the way to understanding colour-blindness. He makes all dichromasy depend upon a single cause, namely want of sensibility in the red-green visual-substance. The difference between red-blindness and green-blindness is, according to him, attributable to different colourations of the media of the eye; partly of the yellow spot of the retina, partly of the crystalline lens.

These colourations are chiefly met with in the sick or the very old, and, when occurring in otherwise useful eyes, are not of such strength that they could bring out conspicuous deficiency of brightness in different parts of the spectrum.

The colouration of the yellow spot of the retina takes effect in a very limited but very important part of the field of view, and in only a narrow band of the spectrum. The most trustworthy observations on the influence of the wave-length of the incident light upon the strength of the red and green excitations, have been made with

kinds of light not liable to be absorbed in notable degree by the yellow pigment. On the whole, it is accordingly found that this pigmentation is subjectively influential only in cases in which the rays in the neighbourhood of the line F play a prominent part, as, for example, in a certain mixture of this blue with red (mentioned on page 354) which, if it looks white when our eyes are directly fixed upon it, will show blue predominant when we look in a slightly different direction.

As far as hitherto-known facts go, it appears very improbable that Hering's theory of dichromasy can be carried through. Nevertheless, further observations in this direction are very desirable. The influence which the colouration of the yellow spot has in individual eyes can be estimated by comparing the appearances of colour-mixtures in the centre of the field of view with their appearances very near the centre. Such comparisons will show with certainty where such influence is present and where it is absent.

The following is a summary, by Prof. Everett, of two passages from the new edition of Helmholtz's "Physiological Optics," which are important as supplementing the foregoing critique of Hering's theory:—

In discussing the results of experiments for determining the exact positions of the three elementary sensations with respect to actual colours, in Newton's diagram or in Lambert's pyramid, Helmholtz represents the results by a triangle with the three elementary sensations at its corners, and with the colours of the spectrum plotted along a curve which lies entirely in the central portion of the triangle. He says, p. 457:—

"This curve shows that every simple colour excites simultaneously in the trichromic eye the three nerve-elements which are sensitive to light, and excites them with only moderate differences of intensity. If we then hypothetically refer all these excitations to the presence of three photo-chemically alterable substances in the retina, we must conclude that all three of these must have nearly the same limits of sensibility to light, and must show, in the rates of their photo-chemical actions for the different wave-lengths, only secondary variations of moderate amount. Similar variations, arising from the presence of foreign substances, from substitutions of analogous atom-groups, and so on, occur also in other photo-chemically alterable substances as used in photography; for example, in the different haloid salts of silver."

In a mathematical discussion of colour-blindness, commencing at p. 458, he points out that in dichromic vision there must be a linear relation between the three independent elements of trichromic vision, and in Lambert's colour pyramid there must be a certain line through the vertex, such that any plane drawn through it is a plane of uniform colour. Newton's diagram of colour may be regarded as contained in any plane which cuts the axis of the pyramid; and it is very important to determine the point in which the above-mentioned line cuts such a plane; for any line in Newton's diagram that passes through this point is a line of uniform colour to the dichromic vision in question. Experiment shows that it always lies outside the triangle of actual presentable colours.

Addendum.

Prof. Everett adds the following remarks of his own on the present position of the problem of colour-vision:—

On the one hand, it is established, as a fact of experiment, that the excitation of colour-sensation in the normal eye depends upon only three variables, and that their effects are superposable, so as to admit of being expressed by equations of the first degree, otherwise called linear equations. The simplest choice of three variables is that adopted in Young's theory, because it only requires positive values of the variables.

On the other hand, the various colours regarded as subjective appearances do not naturally class themselves under a threefold heading. Yellow does not look as if it consisted of red and green. Colour-sensations as known to us in consciousness are not threefold but manifold.

The two facts taken together seem to imply two successive operations intervening between the incidence of light and the perception of colour. The first operation is threefold, and may consist (as above suggested by Helmholtz) of the photo-chemical decomposition of three different substances. The second operation consists in the effects of the first operation upon a complex organism, and the distinctions of colours as we see them arise out of the nature of this organism.

The number of independent variables required for specifying the condition of a system is a very different thing from the number of well-distinguished states in which the system can exist. For example, the state of a given mass of water-substance is completely determined if its volume and temperature are given, and therefore depends on only two variables. But the number of its well-distinguished states is three. In like manner colour depends on three variables, but the number of well-distinguished colours, besides white, may be said to be seven, namely the six principal colours of the spectrum and purple.

What differences of condition in the organism correspond to these eight distinct appearances in the field of view, and how these different conditions are produced by the three primary excitations, are problems awaiting solution.

AUTOMATIC MERCURIAL AIR-PUMPS.

OF late years, and more especially during the last decade, men of science have devoted much thought and ceaseless energy to the invention of an apparatus which should admit of the automatic working of mercurial air-pumps. Of the numerous inventions brought forward, the ingenious apparatus of Schuller and Stearn are especially deserving of mention.

But notwithstanding the present extensive employment of the mercurial air-pump in science as well as in technics these appliances are neither much known, nor have they been used to any great extent, although they are of great importance, and would probably be very advantageous. This may be explained by the fact that they are wanting in the necessary simplicity and trustworthiness, without which the advantages of automatically working mercurial air-pumps are somewhat doubtful.

We shall describe now an apparatus for the perfectly trustworthy and automatic working of mercurial air-pumps, as well as the shape of the glass pump used in connection with it, which, while possessing the greatest possible simplicity, admits of the highest rarefactions hitherto known.

The figure shows the automatic apparatus in connection with an improved Toepler mercurial air-pump. The glass ball H is connected on the one hand by flexible tubes with the pump Q, on the other hand by the tube L with the accumulator M. The water-pipe K runs into the bottom of the accumulator, and by means of a specially-constructed three-way cock K can either be connected with the hydrostatic pressure-pipe K_1 or the discharge-pipe K_2.

If water under pressure is admitted through the tubes k_1, K and k into M, the air contained in M is compressed. This air again exerts a pressure through the tube L on the mercury contained in H, and drives it into the pump Q. As soon as the mercury has risen sufficiently high and the cock K is reversed, the compressed air forces the water out again through k, K, and k_2, and the mercury

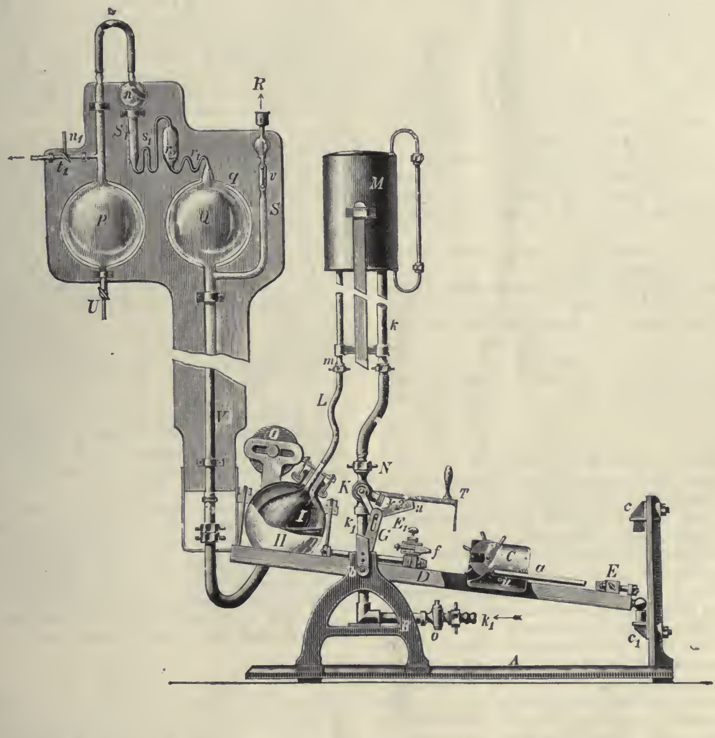
falls down on account of its own weight out of the pump Q back into the ball H.

The reversing of the three-way cock, and therewith the automatic action of the pump, is effected in the following manner:—The ball H rests on a frame D, revolving about the axis b, and the motion of which is limited by the ledges c and c_1. A lever G is attached to the frame not far from the axis, and by means of a peg, when the balance D reverses its position, also turns the cock. When the ball H is entirely filled with mercury the balance D rests on the upper ledge c. If the pump is set in motion the left side of the balance D becomes lighter in proportion to the amount of mercury forced out of the ball H into the pump, until at last the weight C on the right-hand side becomes heavier, and the balance thereby attains the position shown by the figure. The three-way cock is also reversed by this motion.

the adjusting of the height of the mercury can be easily and accurately done up to a centimetre.

It goes without saying that every mercurial air-pump not provided with cocks can be worked by the apparatus just described. But the improved construction of the Toepler pump, drawn likewise in projection in the figure, has proved to be especially practical. The following is a description of its automatic working:—

If the cock t_1 is connected with an hydrostatic air-pump, the ball Q of the pump and the space R, which is to be evacuated through the tube S, is pumped out up to the tension of the vapour. The mercury then rises in the tube R almost to the height of the barometer above its level in the ball H. If the automatic apparatus is then set in motion, the mercury enters the ball Q and the tube S, thus cutting off the connection with R, while any further rising of the mercury



Thus, as already described, the water current is now cut off, the water present in M flows out through K_2, and the mercury goes back from the pump Q into the ball H.

During the tipping over of the balance, however, the sliding weight C has run down its inclined plane to a ledge, E, so that it now exerts a pressure on the lever arm. Its momentum is so calculated that the mercury in the pump must have fallen to the point p, and flowed back into the ball H before it again overweighted, and moves back the balance. The weight C then slides back again to the left until it rests against its left ledge, and the play of the pump recommences. It will easily be seen that the height to which the mercury rises in the pump, the mass of the sliding weight being a constant quantity, depends only on its final positions, and that, therefore,

in the tube S is prevented by a glass valve v, it passes through the first V-tube r_1 filling the little vessel r_2 and rises through s_1 into the ball n, driving before it the air which was before shut off in Q. At this moment so much mercury has been forced out of the ball H into the pump Q, that the balance is turned, the mercury flows back out of Q into H, forming vacua in r_2 and Q, as the little mercury-threads remaining in the side-tubes r_1 and s_1 form shut-off valves. As soon as the mercury has fallen below the entrance-point of S into E the pressure in R and Q become equal, the denser air flowing out through S into Q. The time during which Q is connected with R may be determined at will by changing the right ledge of the sliding weight. Then the balance again changes its position, the mercury rises in

V, and so on. When the pump has made a few strokes in this manner, a lever T is let down, so as to rest on the ledge *u*. The wheel F provided with six pegs is now turned a tooth farther each time the weight C slides from the left to the right, and the ledge-peg *f*, which when the lever was raised caught each time into a notch of the peg-wheel, rests for the length of five strokes of the pump against the circumference of the wheel, and does not catch into the notch until the sixth stroke. As the rising of the quicksilver in the pump is in the inverse proportion of the momentum of the counter-weight in its left final position, if the ledges and peg *f* are rightly placed, it will when ascending be driven five times into the little hollow space r_2 and only at the sixth into the ball *n*. In consequence of this the little air-bubbles are accumulated in the highly evacuated space r_1 in which they ascend owing to the slight counter-pressure, and forming larger bubbles, and having easily overcome the somewhat greater counter-pressure of the mercury column s_1 they rise into the ball P.

All these manipulations are performed *entirely automatically* by the apparatus. At the same time that the toothed wheel has commenced working (*i.e.* when the volume of air pumped out by the pump has sufficiently diminished) the vessel P is entirely cut off from the hydrostatic air-pump by the cock t_1, thus ceasing to act. The mercury of the pump is entirely shut off on *both sides* from the exterior air, and only in contact with perfectly *dry* air. After stopping the pump, concentrated sulphuric acid may be sucked up into P, which dries up entirely. The mercury is shut off from M by a caoutchouc bag, I.

The following experiments were made at the Physical Institute of the University of Berlin:

400 c.cm. (cubic centimetres) were evacuated to 1/1000 m.m. in ten minutes; 4000 c.cm. = 4 litres, in an hour.

The highest rarefaction hitherto obtained has been about from 1/6000,00 – 1/800,000 m.m. = to about $\frac{1}{430000000}$ – $\frac{1}{600000000}$ atmospheres.

The pump is supplied by Messrs. E. Leybolds Nachfolger, Cologne (Germany).

AUGUST RAPS.

CRYSTALLISED CARBON.

IN the course of some researches on the properties and modes of formation of the various forms of carbon, M. Henri Moissan has succeeded in reproducing the variety of diamond known as *carbonado*, or black diamond, and has even obtained some minute crystals of the colourless gem. An account of his results in the *Comptes Rendus* of February 6 is followed by an article on the reproduction of the diamond, by M. Friedel, and some congratulatory remarks by M. Berthelot.

As long ago as 1880 Mr. Hannay[1] indicated the formation of diamond-like crystals on heating under high pressure, in a tube of iron, a mixture of lithium, lampblack, essence of paraffin, and bone oil. It was then supposed that the nitrogenous compounds of the last substance played the most important part. In M. Moissan's new process carbon obtained from sugar is dissolved in a mass of iron, and allowed to crystallise out under high pressure. To produce this pressure the expansion of iron during condensation is utilised. The carbon is strongly compressed in an iron cylinder closed with a screw-stopper of the same metal. A quantity of soft iron, weighing about 150 or 200 gr., is melted in the electric furnace in a few minutes, and the cylinder is plunged into the molten mass. The crucible is at once taken out of the furnace and splashed over with water. When the external crust is at a red heat the whole is allowed to cool slowly in air.

The metallic mass thus obtained is attacked by boiling hydrochloric acid until all the iron is removed. There remain three forms of carbon: graphite in small quantity; a chestnut-coloured carbon in very small needles, such as has been found in the Cañon Diablo meteorite; and a small quantity of denser carbon which has to be further isolated. For this purpose the mixture is treated alternately with boiling sulphuric and hydrofluoric acids, and the residue decanted in sulphuric acid of density 1·8. It then contains only very little graphite, and various forms of carbon. After six or eight treatments with potassium chlorate and fuming nitric acid, the residue is boiled in hydrofluoric acid and decanted in boiling sulphuric acid to destroy the fluorides. It is then washed and dried, and bromoform is employed to separate out some very small fragments denser than that liquid, which scratch the ruby, and, when heated in oxygen at 1000°, disappear.

Some of these fragments are black, others transparent. The former have a rough surface, and a greyish black tint identical with that of certain carbonadoes; they scratch the ruby, and their density ranges from 3 to 3·5. Some pieces have a smooth surface, a darker colour, and curved edges. The transparent fragments, which appear broken up into small pieces, have a fatty lustre, are highly refractive, and exhibit a certain number of parallel striæ and triangular impressions.

During combustion in a current of oxygen at 1050°, some of the fragments left cinders of an ochreous colour, usually preserving the original form of the small crystal—just as in the combustion of impure diamonds.

As indicated already by Mr. Sidney Marsden,[1] silver heated to 1500° in presence of sugar carbon is found to contain on cooling some black crystals with curved edges. M. Moissan has found that high pressure is indispensable. He heated silver till it boiled briskly in contact with carbon, and found that a certain quantity of the latter was dissolved. By suddenly cooling in water, a portion of liquid silver, cooling inside a solid crust, was subjected to a very high pressure. No diamonds were formed, but rather a large crop of carbonadoes of densities ranging from 2·5 to 3·5, thus forming a series connecting graphite with diamond. Bromoform separated a carbonado, which scratched the ruby and burned in oxygen at 1000°. A quantitative determination of this reaction showed that 0·006 parts of this substance gave 0·023 of carbonic acid.

M. C. Friedel describes an experiment in which he obtained a black powder capable of scratching corundum by the action of sulphur on molten iron containing 4 per cent. of carbon. But the question of the production of diamond powder by this means is as yet an open one.

M. Moissan is continuing his researches on the solubility of carbon in iron, silver, and their alloys. It is to be hoped that he will soon be able to exhibit artificial true diamonds of a more imposing size.

[1] Proc. Roy. Soc., vol. xxx. p. 188.

[1] Proc. Roy. Soc. Ed. 1880, vol. ii. p. 20.

LINES OF STRUCTURE IN THE WINNEBAGO CO. METEORITES AND IN OTHER METEORITES.[2]

THE ground and polished surface of a Winnebago Co. meteorite showed to me some interesting markings. Subsequent examination revealed like markings in other meteorites. Perhaps these markings have been described. If so I have no recollection of the description, and therefore it seems worth while to call attention to them.

The polished surface of a small Winnebago stone, three or four square centimetres in area shows several hundreds of bright metallic points. The larger iron particles in this surface have great varieties of shapes—the smaller

[2] Reprinted from the February number of the *American Journal of Science*.

ones are usually mere points. When seen with a lens, or even at a distance from the eye suited to distinct vision there does not appear to be any regular structure or arrangement of the bright points. But if the surface is so held as to be a little beyond the place of distinct vision, and at the same time, turned around in such a way as to reflect always a strong light to the eye, either skylight or lamplight, there appear lines of points across the polished surface of the stone, which suggest very strongly the Widmanstaetten figures on metallic meteorites. At times, as the stone is turned, no lines can be detected. Again one set of parallel lines or two sets crossing each other become visible. Some of the sets are very sharply manifested, and some are so faint as to leave one in doubt whether the lines are real or only fancied. There are on the surface in question six or eight of these sets of lines.

A second surface was ground nearly parallel to the first, at about one centimetre distant from it, and like lines appeared on this parallel surface. Some of the lines, but not all of them, corresponded in direction in the two surfaces. Four more surfaces approximately at right angles to the first surface, and corresponding to the faces of a right prism, were then ground, and upon these surfaces the like sets of lines appear with more or less distinctness.

A slab of a Pultusk stone 6×7 centimetres shows over its entire surface like markings. Something like a curvature of the lines appears in one instance, but in general the lines run straight from side to side of the slab. The slab is six millimeters in thickness, and most of the sets of lines have the same directions upon the two sides.

A Hessle stone, a small slice from the Wold Cottage stone, one from Sierra di Chaco, one from a Sienna stone, a fragment from the Rockwood stone, and a slice from the Rensselaer Co. stone, all show with more or less clearness the like markings. Of three microscope slides of the Fayette Co. meteorite one shows them clearly, a second shows traces of them, the third not at all.

A considerable number of the ground surfaces of meteoric stones in the Peabody Museum also show these markings. For example, a triangular surface of a Weston stone, 8 or 10 centimetres to each side, exhibits them very well.

These markings are such as we might expect if the forces which determine the crystallisation of the nickel-iron of the iron meteorites also dominated the structure of the rock-like formations of the stony meteorites and the distribution therein of the iron particles. The relation of quartz crystals to the structure of graphic granite is naturally suggested by these meteorite markings.

H. A. NEWTON.

THE LATE THOMAS DAVIES, F.G.S.

MR. THOMAS DAVIES, who died on December 21 last, was born on December 29, 1837, in the neighbourhood of London, and was the son of Mr. William Davies, F.G.S., of the Geological Department of the British Museum. His early education was of a very elementary character, and the period of his school-life was brief: finding town-life irksome, and yearning for freedom and adventure, he took to the sea at the age of fourteen, and during the next four years led a roving life, visiting China, India, and various parts of South America. He was then prevailed upon by his father to adopt a more settled mode of existence, and on the separation of the Department of Mineralogy from that of Geology was appointed in 1858 a third-class attendant at the British Museum under Prof. Maskelyne, to whom the care of the minerals had been assigned; in the following year he added to his responsibilities by marriage.

During the next nine years, save for a short interval when Dr. Viktor von Lang was an assistant in the Department, Mr. Davies was the sole helper of Mr. Maskelyne in the arrangement and examination of the mineral collections; during this time Mr. Maskelyne effected a thorough change in the classification and arrangement of the minerals, and in labelling with localities the large number of specimens that were without any descriptions except what could be traced out in old catalogues. In this work, and in the cleaning and arranging some tons of specimens, of which many were entirely valueless, the patient and intelligent aid of "young Davies" alone rendered it possible to carry out the preliminary operations. As the collection grew into orderly arrangement, the registration and labelling of specimens was entrusted to him by Mr. Maskelyne. It was thus that he gradually acquired an eye-knowledge of minerals which has rarely, if ever, been surpassed. His perception of the peculiarities of a specimen was remarkably quick, while his remembrance of individual specimens was almost marvellous. It was particularly in the habit, the locality, the associations and modes of occurrence of mineral species that he concentrated his interest; and to his knowledge in this direction his earlier training, under the eye of Mr. Maskelyne, in the labelling of the minerals, accumulated in the cases and drawers of the collection, very largely contributed.

In the early years of Mr. Davies's museum life Mr. Maskelyne was further engaged in the study of thin sections of meteorites, and initiated Mr. Davies into a knowledge of the microscopic characters of rock-forming minerals, a mode of investigation then almost unknown. In this direction his quickness of perception and excellence of memory had full scope for play, and Mr. Davies soon became extremely skilful in the microscopic determination of minerals in rock-sections, and in the recognition of peculiarities of rock-structure. Few practical petrologists approached him in this faculty.

Nor did he neglect to improve his general education. With this end in view he attended the evening classes at the Working Men's College in Great Ormond Street, and in the course of time acquired a knowledge of both French and German. He was also familiar with plants and fossils, a knowledge largely derived from his father.

His remarkable qualifications attracted the early attention of Mr. Maskelyne, and in 1862 were officially recognised in his promotion by the trustees from the grade of attendant to that of transcriber or junior assistant. In 1880 he was promoted to the grade of first-class assistant. By a remarkable coincidence his father, Mr. William Davies, who had long been renowned for his large practical knowledge of important branches of palæontology, and especially of fossil fishes, and had likewise begun museum life as an attendant, obtained the same promotion on the same day. In the same year Mr. Davies was awarded the balance of the proceeds of the Wollaston Fund by the Council of the Geological Society as a testimony of the value of his researches in mineralogy and lithology. Still later, in 1889, the name of *Daviesite* was given to a new mineral "in honour of Mr. Thomas Davies, who has now been associated during upwards of thirty years with the British Museum Mineral Collection, and whose mineralogical experience and Breithauptian eye have ever been willingly placed at the service, not only of his colleagues, but of every one who has been brought into relationship with him."

He became a Fellow of the Geological Society in 1870, and was an early member of the Mineralogical Society of France.

His published work was not voluminous; it relates almost exclusively to the microscopic characters of the pre-Cambrian rocks. He contributed, however, the bulk of the articles on mineralogy and petrology for "Cassell's Encyclopædic Dictionary," and for some years edited the *Mineralogical Magazine*.

Mr. Maskelyne, for whom he was right-hand man, and almost sole working helper during upwards of twenty years, looks back with fond regret on the uninterrupted happiness of their association. According to my own experience of the last fifteen years, he was an excellent colleague, always cheerful, good-tempered, and kind-hearted, ever ready to help in any direction, however much it might interfere with the particular work he had immediately in hand. At home he was an enthusiastic gardener; wet or fine, absolutely reckless of weather, he was at work from early sunrise, and could boast the possession of one of the best managed gardens in the neighbourhood. His love of fresh air and the bustling east wind never left him; even after recovery from the long illness which two years ago had taken him to the verge of the grave, he did not hesitate to show the greatest contempt for the protection of an umbrella, and notwithstanding the remonstrances of his friends, might still be occasionally seen enjoying the beating of the wind and rain on his unprotected face.

He was an Original Member of the Mineralogical Society, and Foreign Secretary for several years preceding his death.

Mr. Davies leaves a widow and nine children to mourn his loss. L. Fletcher.

NOTES.

At the last meeting of the Council of the Mineralogical Society, it was resolved to initiate a "Thomas Davies Memorial Fund" on behalf of the widow and children of the late Mr. Thomas Davies, F.G.S., of the British Museum. The following gentlemen have consented to act as an Executive Committee:—Prof. N. S. Maskelyne, F.R.S. (chairman), Dr. Hugo Müller, F.R.S. (treasurer), Mr. H. A. Miers, F.G.S. (secretary), Prof. T. G. Bonney, F.R.S., Mr. L. Fletcher, F.R.S., Dr. Henry Hicks, F.R.S., W. H. Hudleston, F.R.S., Prof. J. W. Judd, F.R.S., Mr. F. W. Rudler, F.G.S., Mr. F. Rutley, F.G.S., Rev. Prof. T. Wiltshire, F.G.S., Dr. Henry Woodward, F.R.S. Subscriptions for the fund should be sent to Dr. Hugo Müller, 13 Park Square East, Regent's Park, London, N.W.

An extra meeting of the Chemical Society will be held on February 20, at 8 p.m., the anniversary of the death of Herman Kopp, when a lecture will be delivered by Prof. T. E. Thorpe, F.R.S. Lord Playfair will be in the chair.

An International Botanical Congress is to be held during the Columbian Exposition at Chicago. Prof. C. E. Bessey will receive communications on the subject.

M. P. Duchartie has been elected president, and M. L. Guignard first vice-president, of the Botanical Society of France for the year 1893.

The annual public meeting of the University College Chemical and Physical Society will be held at University College, Gower Street, on Friday, February 24. The chair will be taken at eight o'clock by Prof. F. T. Roberts, and Prof. Watson-Smith will deliver an address on diseases incident to work-people in chemical and other industries.

Mr. Thomas Bryant, president of the Royal College of Surgeons, delivered the Hunterian oration on Tuesday afternoon in the theatre of the college, in the presence of the Prince of Wales and the Duke of York and a large and distinguished company. Mr. Bryant began by thanking their Royal Highnesses for their presence on the special occasion of the centenary of the death of John Hunter, the great founder of scientific surgery. In the course of his oration Mr. Bryant said that the whole world of vegetable and animal life was Hunter's subject, but that his main objects were the improvement of surgery by the elucidation of pathology; the examination of the causes which determine any departure from the normal type, whether of form or function; and the study of the means which nature adopts for the healing of wounds and the repair of injuries. It was one of his special merits that he raised surgery out of the position of a a poor art, based on empirical knowledge and practised too much as a trade, to establish it firmly as a high and elevating science, at the same time raising its practitioners in the social scale, and doing as much for medicine as for surgery, for he considered them inseparable. He made the profession scientific by basing it upon the widest knowledge of the structure and functions of all living things, and educed therefrom laws and principles for the guidance of future generations in their study and treatment of disease in any of its forms. This alone should render him worthy of the thanks of civilised mankind.

Mr. George Mathews Whipple, whose death we briefly recorded last week, had done much solid and valuable work in various departments of physical science. Among the subjects in which he was especially interested were wind force and wind velocities, and throughout the greater part of his life, as the *Times* has said in a brief sketch of his career, he was constantly carrying on experiments with a view to determine wind force and to find out what were the best instruments for securing accurate results. He improved the Kew pattern magnetic instruments; he designed, among other instruments, the apparatus for testing the dark shades of sextants; and at various periods he was associated with Captain Heaviside, Major Herschel, and General Walker, in carrying on pendulum experiments for the determination of the force of gravity. The magnetic part of the report of the committee appointed by the Royal Society to investigate the Krakatoa eruption and the subsequent phenomena was prepared by Mr. Whipple, and valuable papers were from time to time submitted by him to the Royal Society and the Royal Meteorological Society. He was fifty years of age at the time of his death. He entered the Kew Observatory in 1858, became magnetic assistant in 1862, and was appointed superintendent in 1876. This office is one of great and growing importance, and we trust that a capable successor may be found. The Kew Observatory is the central standardising station of the Meteorological Office, and numerous magnetical observatories in other countries are similarly connected with it. New instruments are tested there, and experiments are made, and it has now grown into an institution where the verification of scientific instruments of many kinds, including thermometers, sextants, telescopes, watches, and recently photographic lenses, is carried on on a large scale, as described in the annual report of the Kew committee to the Royal Society.

The Rev. F. O. Morris died at Nunburnholme, in Yorkshire, on Friday last, at the age of eighty-two. He was well-known as a popular writer on science, and did much to create and foster interest in some branches of natural history, especially in ornithology. Among his many books were "A History of British Birds," issued in six volumes from 1851 to 1857, and his "Natural History of the Nests and Eggs of British Birds," published in three volumes in 1853. In 1854 he was presented to the rectory of Nunburnholme, which he continued to hold until his death.

A destructive earthquake has taken place in the island of Samothrace. All the buildings are said to have been destroyed. Renewed shocks, accompanied by loud subterranean rumblings, have also occurred at Zante.

On Sunday a shock of earthquake was experienced in New Zealand. It caused little damage, but was felt in both the North

and South Islands, being most severe at Wellington and at Nelson.

THE weather of the past week has been very stormy and damp in most parts of these islands; scarcely a day has passed without gales being reported. On Friday, the 10th, the wind force was especially strong, on the north-east coast of Scotland and in the English Channel, and on Tuesday another deep depression had reached our northern coasts from off the Atlantic, accompanied by strong gales. The United Kingdom was situated between two areas of high barometer readings, one of which lay over Scandinavia and the other over France and Spain. With this distribution of pressure, the conditions were favourable to the passage of cyclonic disturbances within our area, and although the storms were not of exceptional violence in the southern districts, they were so relatively, as the winds have been peculiarly quiet during the last twelve months. Temperature has been a little above the mean for the season, the daily maxima often exceeding 50°, but on Sunday the highest day readings were below 40° over the north-east of England, while a sharp frost occurred in the north of Scotland, the minimum temperature registering 20°. On the continent the temperature has been much lower than in this country; at Haparanda, at the north of the Gulf of Bothnia, which lies in the area of the high barometric pressure over Scandinavia, a temperature of minus 37° was recorded on Friday and Saturday. Rainfall has been of daily occurrence at most stations, although the amounts measured have generally been light, while hail and sleet have occurred in many places. With Tuesday's storm, however, the rainfall exceeded an inch on the west coasts of Ireland and Scotland. By the *Weekly Weather Report* of the 11th instant it appears that the rainfall for that week was greatly in excess of the mean in the north and west of Scotland, and to a less extent in the east of Scotland, the north of Ireland, and the western parts of England. Bright sunshine exceeded the mean in all districts, the greatest amounts, 32 to 38 per cent., being recorded in most parts of England.

THE recent numbers of *Ciel et Terre* (Nos 21–23) contain interesting articles on ozone. The observation of this element by meteorologists has been almost given up in most countries, owing chiefly to the difficulty of obtaining comparable results by the methods at present in use, although its importance for invalids and others as a purifier of the atmosphere is generally acknowledged. And at a recent meeting of the Royal Meteorological Society, regret was expressed at the discontinuance of these observations. D. A. Van Bastelaer, in conjunction with the Royal Observatory of Brussels, maintained a system of ozone observations at 150 of the stations belonging to the Society of Public Medicine in Belgium during the years 1886–91, which is probably the most complete investigation into the subject which has been made. The values found for the various stations are given in a tabular form, and M. Van Bastelaer found that there are continual and sudden variations in the records from hour to hour, between morning and evening, and from one day to another, but that the mean values for any locality remain nearly constant. Isolated values are of no use; a long series of observations is necessary for any results of importance to be arrived at. The air at stations near the sea coast contained, as is usually supposed, the greatest amount of ozone.

THE Indiana Academy of Science lately held at Indianopolis its eighth annual meeting, the president being Prof. J. L. Campbell, of Wabash College, Crawfordsville, Ind. There was a large attendance, and no fewer than ninety-two papers had been prepared, most of which were read. The first volume of the Academy's Proceedings was distributed at the meeting.

THE *Kew Bulletin* continues, in the January number, its series of articles on the food grains of India, one of the subjects being Kangra Buckwheat (*Fagopyrum tataricum*, Gærtn., var. *himalaica*, Batalin). The typical plant is cultivated throughout the higher Himalayas, but more especially on the western extremity, and at altitudes from 8000 to 14,000 feet. The yield in India cannot yet be estimated, but the *Bulletin* says there can be little doubt that the seeds are singularly rich in nutrient constituents. This is confirmed by the conclusions of Prof. Church with regard to a sample he has examined.

THE January number of the *Kew Bulletin* contains also the fourth decade of new orchids, the fourth of "Decades Kewenses," papers on fruit growing at the Cape and the clove industry of Zanzibar, and miscellaneous notes.

PROF. R. SHIMEK is now investigating the flora and the geology of Nicaragua, along the route of the canal, under commission from the State University of Iowa. Dr. Terracciano, of Rome, is about to renew his investigation of the flora of Erythrea, the Italian colony on the Red Sea. Dr. K. N. Denkenbach is commissioned by the Natural History Society of St. Petersburg to investigate the flora of the Black Sea.

MR. R. THAXTER proposes in the *Botanical Gazette* the establishment of a new order of Schizomycetes, the Myxobacteriaceæ, somewhat intermediate in its characters between the typical Schizomycetes and the Myxomycetes. It comprises the genus Chondromyces, placed by Berkeley, in his "Introduction to Cryptogamic Botany," under the Stilbacei, and two new genera, Myxobacter and Myxococcus. The order consists of mobile rod-like organisms, multiplying by fission, secreting a gelatinous base, and forming pseudo-plasmode-like aggregations before passing into a more or less highly-developed cyst-producing resting state, in which the rods may become encysted in groups without modification, or may be converted into spore-masses.

AT the meeting of the Royal Botanic Society on Saturday, one of the branches of the flowering stalk of *Fourcroya selloa* was shown from the Society's conservatory. This is a Mexican plant allied to the aloes, and like them it flowers only once during its life. The plant, which has been in the conservatory for upwards of twenty years, late last autumn threw up a flower spike which in a very short time grew to a height of 30 feet, and, passing through the glass roof, rose for some feet into the open air. It could not, of course, resist the frosts and fogs of winter. The flower-buds dropped unopened, when immediately from each node a number of young plants appeared. This mode of reproduction is found in only a few varieties of plants, and is especially valuable in relation to the cultivation of Fourcroyas as a source of commercial vegetable fibre.

THE Newcastle Literary and Philosophical Society will have no very pleasant associations with the memory of its hundredth anniversary, which was celebrated on Tuesday of last week. During the following night the society's premises caught fire and were greatly damaged. Much injury was done to the library, where many most valuable books were destroyed.

THE fifth and sixth parts of the fifth volume of the *Internationales Archiv für Ethnographie* have been issued together in a single number. It includes the second part of Dr. W. Svoboda's interesting study (in German) of the inhabitants of the Nicobar Islands; a paper (in French) by Désiré Pector on the volume by Dr. Hyades and Dr. Deniker (noticed some time ago in NATURE) on the ethnography of a part of Tierra del Fuego; a suggestive essay (in German) by Dr. T. Achelis, on the psychological importance of ethnology; and the second part of Dr. Schmeltz's careful contributions (in German) to the

ethnography of Borneo. The first and last of these papers are admirably illustrated. A valuable paper on the Ainos, by David MacRitchie, of Edinburgh, has been published as a supplement to the fourth volume of the *Archiv*. This paper is accompanied by, and contains full descriptions of, a series of coloured reproductions of most interesting pictures of Aino life by Japanese artists, who have naturally a keener perception of the characteristics of their savage neighbours than can be attained by Western visitors. Mr. MacRitchie seeks to show that the Ainos display "unmistakable traces of a near descent, by at least one line of their ancestry, from the most crude form of humanity."

Messrs. Samson and Wallin, Stockholm, are about to issue what promises to be an important and interesting work, by F. R. Martin, on the Siberian Antiquities of the Bronze Age, preserved in the museum of Minousinsk. Nearly 900 objects in copper and bronze will be represented in the plates, which, according to the prospectus, are being prepared with the greatest care. The antiquities of which these objects are selected specimens were collected in 1874 by M. Nicolaï Martianow from mounds in the steppes of the Upper Yenisei. They are the finest provincial collection in the Russian Empire, and M. Martin found much to interest him in classifying and photographing them. The present volume will be the first of a series of works on the ethnography and archæology of Western Siberia by the same writer.

The third volume of "A Journal of American Ethnology and Archæology," edited by J. Walter Fewkes, has been issued. It contains an interesting "outline of the documentary history of the Zuñi tribe," by A. F. Bandelier, and "somatological observations on Indians of the south-west," by Dr. H. F. C. Ten Kate. It is worth while to note that in Dr. Ten Kate's opinion the study of physical anthropology among the North American Indians does not tend to demonstrate that their types are exclusively American. It rather shows, he thinks, that they present only the characteristics of "the Mongolian or so-called yellow races." "I do not mean," he says, "that the American aborigines are Mongolians in the strict sense of the word, or that America has been populated from Asia. Where the Indians came from I do not know, but my position is as follows:—The American race is, somatologically speaking, not a type, but has characteristics which can only be called Mongoloid."

Probably no living sportsman has shot more big game in South Africa than Mr. F. C. Selous, who for years was more at home in a waggon or a tent somewhere in the far countries of Africanderland than in the towns and settlements of the Cape Colony or the Transvaal. He has nearly completed an account of eleven years' sport and travel, which will be shortly published by Messrs. Rowland, Ward and Co., of Piccadilly. It will be fully illustrated, and will include a variety of general information on subjects of interest in connection with the latest developments of South African exploration.

Mr. Elliot Stock has published the third volume of "The Field Club," a magazine of general natural history for scientific and unscientific readers, edited by the Rev. Theodore Wood. The volume contains many articles which are well fitted to awaken interest in various aspects of natural science.

We referred lately to Dr. D. G. Brinton's opinion as to the relation between nervous diseases and civilisation. As his view has been called in question by Dr. Rockwell, he returns to the subject in *Science*, supporting his own conclusions by a reference to a paper contributed by Dr. I. C. Rosse, professor of nervous diseases at the Georgia Medical College, to the *Journal of Nervous and Mental Disease* for July, 1891. In this paper Dr Rosse cites many authorities to prove that there is as much nervous disease at low as at higher stages of civilisation, and perhaps more. In the district of Columbia, for example, the decedents among the coloured people from nervous diseases often exceed those of the white population by thirty-three per cent. Dr. Rosse is inclined to believe that a sudden change in the social habits and condition of any race, at any stage of advancement, will result in a prompt development of neurotic disease. A high civilisation, which is stable, excites such a condition less than instability in lower grades.

At the meeting of the Field Naturalists' Club of Victoria in November a paper presenting a list of species of Victorian butterflies was communicated. It had been prepared by Messrs. F. Spry and Ernest Anderson, and embodied the results of work carried on during many years. The *Victorian Naturalist* says the paper was "received with great satisfaction, and will prove of extreme value to the Victorian lepidopterist."

Mr. H. L. Clark records in *Science* what he calls "a bit of satisfactory evidence" as to the rate of speed in the flight of certain birds. He thinks that this is often greatly exaggerated. He was travelling lately on the Baltimore and Ohio Railway, up the valley of the Potomac, when he saw a great many wild ducks, which are admitted to be among the strongest flyers in America. It so happened that, on rounding a sharp curve, the train flushed a pair of buffle-heads, which started up stream at full speed. On watching them he found that, instead of their leaving the train behind, the train was actually beating them, and he is confident that their rate of speed was not equal to that of the train. "We kept alongside of them," he says, "for nearly a minute before they turned back down-stream. Careful calculation showed that the train was running at about thirty-seven miles per hour, so that the rate of speed for those wild ducks would be about thirty-six. I hope that others may have some evidence on this question of speed in flight which will throw more light on the subject."

An interesting illustration of the tendency of inorganic matter to simulate the forms seen in organic is afforded by some specimens of hæmatite from a mine in Lake Superior district. It is described in the *American Geologist* as a fibrous red hæmatite, compact and tough-looking, and the radiating filaments or fibres towards their summits are seen to spread out like some frondescent vegetable growths. It would seem that in process of increase these fibres, starting from different but slightly distant points, and having a tendency to expand, soon began to interfere with one another. The line of contact, which became a plane as growth continued, is marked by a more or less distinct plane of separation. This frondescent hæmatite, in addition, is pierced by a number of peculiar channels which seem to date from the time of development of the crystals. It is noticed that these run, in general, perpendicular to the fibrous structure, and lie in or across the planes of contact of two oppositely spreading frondescent growths. These appear to mark in the first instance the vacancies left by the first contacts of overarching growths from opposite directions. These branches then interfered with the free circulation of air, and interrupted and permanently stopped the development of these fibres beneath the overspreading canopy.

It was shown by Ferraris some time ago (and the fact was of great practical importance) that by means of two simple alternating currents acting in fixed spirals, a rotating magnetic field could be produced, which by inductive action set in rotation a copper cylinder or other conducting body brought into the field. Also an iron cyclinder, cut through so that the Foucault induction currents could not be formed, was rotated by virtue of so-called magnetic hysteresis. Further studies in this direction have been made by Signor Arno, using electric instead of magnetic forces, and a dielectric body instead of a magnetic.

He thus succeeded in rotating a hollow cylinder of mica, or other insulating substance, hung by a silk fibre, in the space enclosed by four vertical curved copper plates, to which the requisite differences of potential were communicated. An account of these interesting experiments (described to the Accademia dei Lincei) will be found in the *Naturwissenschaftliche Rundschau*, No. 3, 1893.

PROF. R. C. SCHIEDT has been making some interesting observations on oysters, and at a recent meeting of the Philadelphia Academy of Natural Sciences Prof. Ryder reported on his behalf that oysters which had the right valve removed and were exposed to the light in this condition, in a living state for a fortnight or so, developed pigment over the whole of the epidermis of the exposed right mantle and on the upper exposed sides of the gills, so that the whole animal from this cause assumed a dark-brown colour. Animals so exposed not only attempted to reproduce the lost valve and hinge, but also partly succeeded in so doing, even re-establishing the insertion of the diminutive pedal muscle upon the inner face of the imperfectly reproduced right valve, which was deformed owing to the lack of support of the right mantle, because of the removal of the original right valve. As a consequence the right mantle was rolled up at the edge, and this deformation of the mantle was reflected in the attempted regeneration of the lost right valve. The pigment developed during exposure to light in the mantle and gills in oysters with the right valve removed, which were kept alive in the aquaria at Sea Isle City by Prof. Schiedt, was wholly confined to the epidermis as it normally is at the mantle border in the unmutilated animal in nature. The inference to be drawn from these facts is that the development of pigment in the mantle and gills was wholly and directly due to the abnormal and general stimulus of light over the exposed surface of the mantle and gills, due to removal of the right valve, and that the mantle border, the only pigmented portion of the animal, is pigmented because it is the only portion of the animal which is normally and constantly subjected to the stimulus of light.

MR. D. CLEVELAND, of San Diego, California, contributes to *Science* an article in which he states some curious facts regarding the trap-door spider (*Mygale henzii*, Girard), which is widely diffused in California. Behind San Diego there are many hillocks about a foot in height and three or four feet in diameter. These hillocks are selected by the spiders, Mr. Cleveland suggests, because they afford excellent drainage and cannot be washed away by the winter rains. A suitable spot, which always consists of clay, adobe or stiff soil, having been chosen, the spider excavates a shaft varying from five to twelve inches in depth, and from one-half to one and a half inches in diameter. This is done by means of the sharp horns at the end of the spider's mandibles, which are its pick and shovel and mining tools. The earth is held between the mandibles and carried to the surface. When the shaft is of the required size, the spider smooths and glazes the wall with a fluid which is secreted by itself. Then the whole shaft is covered with a silken paper lining, spun from the animal's spinnarets. The door at the top of the shaft is made of several alternate layers of silk and earth, and is supplied with an elastic and ingenious hinge, and fits closely in a groove around the rim of the tube. This door simulates the surface on which it lies, and is distinguishable from it only by a careful scrutiny. The spider even glues earth and bits of small plants on the upper side of the trap-door, thus making it closely resemble the surrounding surface. The spider generally stations itself at the bottom of the tube. When, by tapping on the door, or by other means, a gentle vibration is caused, the spider runs to the top of its nest, raises the lid, and looks out and reconnoitres. If a small creature is seen, it is seized and devoured. If the invader is more formidable, the door is quickly closed, seized, and held down by the spider, so that much force is required to open it. Then the spider drops to the bottom of the shaft. When the door of the nest is removed, the spider can renew it five times—never more than that. From forty to fifty cream-coloured spiderlings are hatched from the yellow eggs at the bottom of the nest. When these have attained only a fraction of their full size—before they are half grown—the mother drives them out into the world to shift for themselves. After a brief period of uncertainty they begin active life by making nests, each for itself, generally close to "the old homestead," sometimes within a few inches of it. These nests are always shallow and slender, and are soon outgrown. When the spider attains its full size it constructs a larger nest.

AN interesting paper concerning the supposed volatility of the element manganese is contributed by Prof. Lorenz and Dr. Heusler, of Göttingen, to the current number of the *Zeitschrift für Anorganische Chemie*. Although the melting point of the metal is known with tolerable certainty to be about 1800°–1900°, much higher than that of iron, no information has yet been acquired concerning its boiling point. Profs. Lockyer and Chandler Roberts, however, so long ago as 1875 pointed out that the metal was volatile at the temperature of the oxy-hydrogen blowpipe; and M. Jordan, in a communication to the *Comptes Rendus* in the year 1878, reported that in the manufacture of highly manganiferous spiegeleisen near Marseilles, a deposit very rich in manganese was usually found in the cooler portions of the furnace. Moreover, M. Jordan stated that during the casting of ferro-manganese red flames are produced, from which a heavy fume is deposited containing a large percentage of manganese. M. Jordan subsequently heated ferro-manganese to a white heat in a crucible in his laboratory, and ascertained that a diminution in the percentage of manganese actually occurred. These observations were considered somewhat surprising, inasmuch as the melting point of manganese is so high, in the neighbourhood of white heat, and it would appear that this volatility must be exhibited even at the melting point itself.

PROF. LORENZ and his colleague have therefore conducted a series of experiments with the view of ascertaining whether manganese is really volatile *per se*, or whether the volatility is due to the intermediate action of carbon monoxide (derived from the carbon usually present) in forming a volatile but dissociable compound of a nature similar to nickel- and iron-carbonyl. It was first definitely proved that carbon monoxide does not combine with manganese below the temperature of 350°, a fact which M. Guntz has recently independently pointed out. Experiments were then made at higher temperatures, using a new form of combustion furnace, designed by Prof. Lorenz and fully described in the *Zeitschrift*, in which each individual burner is supplied with a blast capable of being regulated, the whole apparatus being equivalent to a row of blowpipes which will rapidly raise a thick porcelain tube up to a white heat. In the first series of these high temperature experiments coarsely powdered manganese containing seven per cent. of carbon was heated to whiteness in a glazed porcelain tube in a current of carbon dioxide, in order that nascent carbon monoxide might be produced in contact with manganese by the reduction of the carbon dioxide by the carbon present. After half-an-hour's heating the tube was allowed to cool in the stream of carbon dioxide and then broken, when it was found that a large quantity of the manganese had volatilised and condensed again further along the tube, in the form of a thick black deposit somewhat resembling zinc dust. Upon repeating the experiment with a current of carbon monoxide, a similar result was obtained. Hence manganese is certainly volatile in carbon monoxide. But it was afterwards found that equally good deposits of manganese dust were obtained when a current of

either hydrogen or nitrogen, neither of which combine with manganese, were employed. It is therefore evident that manganese does not resemble iron and nickel in forming a volatile compound with carbon monoxide, but that the volatility is a property of the element itself, and is singularly manifested even at the temperature of the melting point.

SOME of the more interesting captures recently made by the dredging staff of the Marine Biological Association at Plymouth are the Actinian *Chitonactis coronata*; the Nudibranchs *Berghia cærulescens* (new to Britain), *Amphorina cærulea*, and *Lamellidoris oblonga* in considerable numbers; and the handsomely marked rare spider-crab, *Stenorhynchus egyptius*. The alga *Halosphæra viridis* has been present in all townettings since October; and *Noctiluca*, though in small numbers, is now generally present. The breeding season of a large number of Invertebrata has already commenced, and the sea swarms with Copepod and Cirrhipede Nauplii, and with Polychæte larvæ. Species of the following genera are breeding:—The Hydroids *Halecium*, *Plumularia*, *Sertularella*, *Hydrallmania*; the Actinians *Chitonactis* and *Actinia*; the Nemertine *Lineus obscurus* (larva of Desor); *Phyllodoce maculata* and other Annelids; the Molluscs *Capulus hungaricus*, *Lamellaria*, *Buccinum*, *Purpura*, many Nudibranchs; and the Decapod Crustacea *Crangon*, *Pandalus*, and *Palæmon*; *Carcinus*, *Cancer*, and *Eurynome*.

THE additions to the Zoological Society's Gardens during the past week include a Fallow Deer (*Dama vulgaris* ♂) European, presented by Mr. B. L. Rose; a Great Eagle Owl (*Bubo maximus*) European, presented by Mr. Adolphus Drucker; two Gold Pheasants (*Thaumalea picta* ♀ ♀) from China, presented by Miss Forster; nine Snow Buntings (*Plectrophanes nivalis*) British, presented by Mr. T. E. Gunn; an Egyptian Cobra (*Naia haje*), two Hoary Snakes (*Coronella cana*), from Victoria West, Cape Colony, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; three European Pond Tortoises (*Emys europæa*) European, deposited; a King Snake (*Coluber getulus*) from North America, received in exchange.

OUR ASTRONOMICAL COLUMN.

THE TOTAL SOLAR ECLIPSE OF APRIL 15–16, 1893.—The following particulars of the phenomena of the total solar eclipse of April 15–16, 1893, have been supplied to the Eclipse Committee by Mr. A. M. W. Downing, Superintendent of the *Nautical Almanac* office, for the use of the English observers at the eclipse stations to be occupied in Brazil and Africa:—

Brazil. Longitude 38° 50′ W. Latitude 3° 20′ S.

	d. h. m. s.	Contact from N. point.	Contact from vertical.	Sun's altitude.
Eclipse begins	April 15 22 18 14	136° W.	19° W.	62°
Totality begins	15 23 40 51	Duration 4m. 43·1s.		
Totality ends	15 23 45 34			
Eclipse ends	16 1 11 40	45° E.	84° W.	68°

Local mean times.

Senegambia. Longitude 16° 30′ W. Latitude 14° 15′ N.

	d. h. m. s.	Contact from N. point.	Contact from vertical.	Sun's altitude.
Eclipse begins	April 16 1 5 3	130° W.	156° E.	73°
Totality begins	16 2 27 59	Duration 4m. 12·3s.		
Totality ends	16 2 32 12			
Eclipse ends	16 3 48 1	57° E.	24° W.	35°

Local mean times.

REMARKABLE COMETS.—Bearing this title, Mr. Lynn has written a small book, in which he gives a short survey of the most interesting facts that have occurred in the history of cometary astronomy. As he remarks in the preface, the scope of the work is almost purely historical; but we are sure there are many who will peruse these few pages with great pleasure, for the author has brought together these facts and presented them to the reader in a concise and plain style. We may mention that figures relating to elements of orbits, &c., are at a minimum, Mr. Lynn simply restricting himself to bare accounts. The author concludes by giving a list of the dates at which some of the comets may reappear, from which we make the following extract:—

Date.		Period in years.	
1893	Summer	$6\frac{1}{2}$	Finlay's Comet
1894	Winter	$3\frac{1}{3}$	Encke's ,,
1896	Spring	$7\frac{1}{2}$	Faye's ,,
,,	,,	7	Brook's ,,
1897	,,	$6\frac{1}{2}$	D'Arrest's ,,
,,	,,	$5\frac{1}{2}$	Swift's ,,
1898	Summer	$5\frac{1}{2}$	Winnecke's ,,
,,	Autumn	7	Wolf's ,,
1899	Spring	$33\frac{1}{4}$	Comet of 1866
,,	Summer	$13\frac{3}{4}$	Tuttle's Comet
,,	,,	7	Holmes's ,,

The comet of 1866, as many of our readers well know, is identical with the meteoric stream through which we pass in November, so we hope that we shall be visited by a fine display.

COMET HOLMES (1892, III.).—Comet Holmes seems to have become somewhat dimmed during the past week, but we nevertheless give the ephemeris for the benefit of those who wish to follow it a little longer.

Ephemeris for 12h. M.T., Paris.

1893.	R.A. app. h. m. s.	Decl. app. h. m. s.
Feb. 16	2 7 37·9	+34 14 30
17	9 15·3	16 42
18	10 53·2	18 58
19	12 31·5	21 16
20	14 10·3	23 37
21	15 49·5	26 1
22	17 29·1	28 26
23	2 19 9·2	34 30 54

COMET BROOKS (NOVEMBER 19, 1892).—This comet lies in the southernmost part of the constellation of Andromeda, just south of ε Andromedæ, and the following is the current ephemeris:—

Ephemeris for 12h. M.T., Berlin.

1893.	R A. app. h. m. s.	Decl. app. ° ′	Log r.	Log Δ	Br.
Feb. 16	0 22 44	+26 46·9			
17	24 8	26 23·2	0·1343	0·2445	0·97
18	25 30	26 0·3			
19	26 50	25 38·3			
20	28 8	25 17·1			
21	29 23	24 56·7	0·1438	0·2711	0·83
22	30 37	24 37·1			
23	0 31 49	24 18·2			

RELATIVE POSITIONS OF STARS IN CLUSTER χ PERSEI.—Volume xxx. part iv. of the Transactions of the Royal Irish Society contains the results of the investigations of Sir Robert Ball and Mr. Arthur Rambaut, with respect to the relative positions of 223 stars in the cluster χ Persei as determined photographically. The instrument used throughout was a 15-inch silver on glass reflecting telescope, mounted according to Cook's standard equatorial pattern. For the adjustment of the plate (the size used here being $3\frac{1}{4} \times 3\frac{1}{4}$) and mirror Dr. Johnstone Stoney's collimator was employed, this method ensuring the exact perpendicularity of the photographic plate to the axis of the collimator. The negatives were measured with an instrument made by the same firm, and after the same pattern as that used by Prof. Pritchard, at Oxford, this instrument being supplied with the means of measuring either rectangular or polar coordinates, the former of which has been adopted here throughout. In this memoir the authors treat in detail, by means of figures and formulæ, the equations for orientating the plate for measurement, for computing the differences in Right Ascension and Declination from the centre of the plate, for correcting the relative apparent positions of the stars for effects of separation, observation, nutation, and procession, &c. The measures here given have been obtained from one photograph taken with an exposure of ten minutes, the images under the microscope being susceptible "of very accurate measurement." That only

one negative has been employed is due, as the authors say, to pressure of other work and to necessary alterations in the instrument, but they hope to repeat the investigation next autumn. In the table showing the positions, the authors compare their results with those of Vogel and Pihl, and they find that a small difference, depending on the adopted position of the fundamental star, is apparent between the former's declinations, while Pihl's right ascensions differ slightly, though systematically, this discrepancy being due very probably to the different methods of determining the parallels. The memoir concludes with a map showing the relative positions of the stars plotted direct from the x and y coordinates.

L'ASTRONOMIE.—The February number of this journal contains many articles of interest. Prof. Stanislas Meunier gives an account of a meteorite that fell in Algeria; this meteorite has proved to be of iron, containing as much as 91·32 per cent., and a polished surface, when treated with an acid, showed the well-known Widmannstätten figures. M. Flammarion, in addition to an account of "Les Pierres Tombées du Ciel," with reference to "Les Anciens Volcans de la Lune," lately advocated by Prof. Coakley in *Astronomy and Astrophysics*, gives the fourth out of six chapters dealing with the question, "Comment Arrivera la fin du Monde." M. J. Fényi, director of the Observatory of Kalocsa, gives an account of the enormous solar eruption (383,000 kilometres high) that occurred on October 3 last, while a short note on some curious appearances undergone by comet Swift includes six drawings by M. Lorenzo Kropp, taken between March 18 and April 25, and the three photographs taken at the Lick Observatory by Mr. Barnard, all of which indicate the results of tremendous actions, whether they be due to the influences of different forces, "attraction, repulsion, chaleur, électricité, or changements d'état, qui ajissement sur ses astres gazeux dans leur voisinage du soleil." M. Weinck of Prague describes the results of his examination of the Lick negatives with reference to the lunar crater Flammarion, and gives a drawing (which, by the way, can be well seen by half closing the eyes) of its surroundings, together with the three new craters. This number also includes a general summary of the meteorology of the preceding year, the results being given in diagrammatic form, bringing out clearly the diurnal and monthly changes.

JUPITER'S FIFTH SATELLITE.—Mr. Barnard, who has been continuing his observations with respect to the fifth satellite of Jupiter, communicates the results he has obtained to the *Astronomical Journal* (Nos. 285-86). The values of the elongation distances deduced from the measures at elongations are, for eastern elongation, $48''·089$ ($\pm$ 0·061), and for western elongation, $47''·621$ (($\pm$ 0·176), the probable errors of a single determination being $\pm\,0''·23$ and $\pm\,0''·47$ respectively. These values are equivalent to the following distances:—

E. elongation	112,500 $\pm$ 143 miles	
W. ,,	111,412 $\pm$ 412 ,,	

The values for the period he gives as

		h. m. s.
September 10–October 21	...	$P =$ 11 57 23·72
September 10–October 28	...	$P =$ 11 57 23·30
September 10–November 20		$P =$ 11 57 22·73

the mean, when proportional weights are applied, being—

11h. 57m. 23·06s.

Among some other figures which Mr. Barnard gives are:—

Hourly motion	30°·111
Velocity in orbit	16·4 miles per second
Equatorial Hor. Par.	21° 51′

Distance from surface of Jupiter 67,000 miles (about).

While working at this satellite he has also been led to measure the equatorial and polar diameters of Jupiter himself, and the following numbers show the values he has deduced, the observations being made through smoked glass:—

Equatorial diameter	89,790 $\pm$ 65 miles
Polar ,, ...	84,300 $\pm$ 80 miles

GEOGRAPHICAL NOTES.

THE *Times* Berlin correspondent furnishes some interesting notes of Dr. Baumann's recent journeys in the region of the Nile sources, which confirm Mr. Stanley's identification of the Mountains of the Moon. In Urundi the kings were supposed to be lineal descendants of the moon, and the white traveller was hailed as being the returned ghost of a lately-deceased chief. On September 11 the expedition crossed the Akenyaru, which is not, as supposed, a lake, but a river, though the name "Nyanza" is often applied to it. Dr. Baumann also discovered that the so-called Lake Mworengo is in reality a river which flows into the Akenyaru, and came to the conclusion that there was no extensive sheet of water in Ruanda or North Urundi. On September 19 Dr. Baumann arrived at the source of the Kagera (Alexandra Nile), which rises at the foot of the precipitous and wooded hills which form the watershed between the basins of Rufizi and the Kagera. This mountain chain is known to the natives by the name of the "Mountains of the Moon," and is held in peculiar reverence by them. Here Dr. Baumann maintains the real source of the Nile to be, for if "it be acknowledged that the Kagera is the chief feeder of the Victoria Nyanza, it follows that the headwaters of the Nile can be none other than those of the Kagera itself in the Mountains of the Moon in Urundi, within the boundaries of German East Africa."

THE often-discussed scheme of an expedition to the North Pole by way of Franz Josef Land has been revived by Mr. F. G. Jackson, who proposes to lead an expedition next summer, if the means for equipping a ship are forthcoming. Mr. Jackson's plan is to travel with a small party, and establish a chain of depots northward from the most northerly accessible landing-place in Franz Josef Land. He would remain during winter in the most advanced post, and push on each summer with dog-sledges, until the pole is reached. The plan rests on the hypothesis of Franz Josef Land extending to the pole, just as Dr. Nansen's rests on the hypothesis of a transpolar current, but the evidence of the great extension of the land is not very satisfactory. Mr. Jackson's previous Arctic experience is not stated, nor is there any indication given as to whether he intends to travel at his own expense or to appeal for pecuniary help.

THE British South African Company have reserved the Zimbabwe Ruins and the area within a radius of one mile from the top of Zimbabwe Hill for archæological and scientific purposes, and no settlements, farms, or mines will be permitted within that radius.

A BEAUTIFULLY illustrated report on the regulation of Swiss torrents, by the late M. de Salis, has recently been published by the Swiss Government. The natural erosion and surface change which go on at the present day so rapidly among the steep slopes of a mountainous country as to be frequently cataclysmic in their intensity, have to be avoided or endured in inhabited regions. A frequent source of floods is the damming up of a large river by the mud and stones brought down by a freshet in a small tributary. The method of combating this effect is to build a succession of weirs, and cut a parallel canal so that the sediment is caught and the overflow regulated before the escaping water reaches the main valley.

MR. MACKINDER'S fourth Royal Geographical Society's educational lecture, delivered last week, dealt with Central Asian trade- and travel-routes, under the title of "The Gates of India and China."

TWENTY YEARS IN ZAMBESIA.

MR. F. C. SELOUS, the famous hunter and explorer of South Central Africa, gave a summary of his travels to the Royal Geographical Society on Monday evening. His address was illustrated by an exhibition of unusual interest in the tea-room, where a large collection of stuffed specimens of the characteristic African mammalian fauna was arranged. Photographs and various objects illustrative of the rapid development of Mashonaland since the Chartered Company took possession were also shown.

Mr. Selous commenced his African wanderings in 1871, and except for occasional visits to England he has travelled and traded in that continent ever since. In 1872 he and some companions penetrated into Matabeleland to hunt elephants, and had an amusing interview with the chief, Lo-Bengula. Although at that time not an explorer in the scientific sense, the accurate memory of his early wanderings over the country enabled Mr.

Selous to successfully guide the Pioneer Force of the Chartered Company in 1890, when they took possession of Mashonaland.

With regard to the health of Zambesia he says :—"Owing to severe exposure to wet and cold during several days and nights, in the early part of 1872, I got an attack of fever and ague in Griqualand so that I was handicapped before starting for the interior. This fever and ague was exactly what I have seen people get on the high plateau of Mashonaland, during the last few years, from similar exposure to rain and cold. It took me some time to shake off, and was still in my system when I reached Matabeleland, but the attacks only came on when I halted anywhere for a few days. During November and December, 1872, hunting down in the low hot country towards the Zambesi, I was again very much exposed to wet, and on several occasions lay out all night long, without any shelter, drenched through with such heavy rain that it put out the largest fire and converted hard ground into a swamp. I naturally again got soaked with fever poison, but as long as I remained hunting the disease did not show itself. Directly I got back to Bulawayo it broke out, and during a month or so I had several sharp attacks. By that time, however, my sound constitution had choked all the fever germs, and from that day until in 1878, when very severe exposure in Central Africa once more filled me up with malarial poison, I do not remember ever to have had one single hour's illness, or to have taken one drop of medicine. The life I led was, however, if a very hard, at any rate, in many respects, a very healthy one; for the most part I ate nothing but meat and Mashona rice, and drank nothing but tea, usually without milk and sugar—not because I like it so, but because those adjuncts were unobtainable."

North of the Zambesi Mr. Selous made several journeys among the Batongas, and spent a wretched rainy season, almost without equipment, on the Manica table-land. After the rains the country looked charming. The young grass, thanks to the recent heavy rain, had shot up one foot or eighteen inches in height over hill and dale, every tree and shrub was in full leaf, and everything looked green, and fresh, and smiling. Many of the shrubs on the edge of the hills bore sweet-smelling flowers, and, as on all the plateaus of the interior of Africa, small but beautiful ground-flowers were very abundant.

Interesting observations were made on some of the northern rivers. The curious phenomenon of the steady rise of the waters of the Chobe and Machabi—an outlet of the Okavango—was observed from the first week in June until the last week in September, when they commenced to recede. That the Okavango and the Upper Kwando are connected on their upper courses, there can be little doubt, as the waters of the Machabi went on rising suddenly *pari passu* with the Chobe, until the end of September, when both commenced to recede simultaneously.

The explanation of this remarkable phenomenon is difficult, as there are no snow mountains at the sources of the Kwando and Okavango rivers and the Zambesi, which rises in the same latitude, decreases steadily in volume from day to day during the dry season like almost all other rivers in South Central Africa. Besides the channels which still become annually filled with water from the overflow of the Chobe and Okavango river systems, there are many others which are now quite dry, but in which the natives say they once used to travel in canoes.

From 1882 the journeys acquired additional geographical importance, and Mr. Selous proceeded to rectify the maps of Mashonaland laid down by earlier travellers, taking constant compass bearings, sketching the course of rivers, and fixing the position of the junction of tributaries. The value of this work was made manifest in a magnificent large scale map of the country, drawn as well as surveyed by Mr. Selous, which was used to illustrate the lecture. It would be impossible, without practically reproducing the whole address, to do justice to the immense variety and solid value of the contributions to African geography made by this most energetic of pioneers; or to the thrilling adventures, the recital of which was listened to with breathless attention and greeted with the heartiest applause. With the exception of a treacherous night attack made upon his camp by the Mashuku-sumbwe, led by a few rebel Marotse, in 1888, he had never had any other serious trouble with the natives. During his twenty years' wanderings he went amongst many tribes who had never previously seen a white man, and he was always absolutely in their power, as he seldom had more than from five to ten native servants, none of whom were ever armed.

THE DISTRIBUTION OF POWER BY ELECTRICITY FROM A CENTRAL GENERATING STATION.

ON Friday evening, the 3rd inst., Mr. A. Siemens delivered at the Royal Institution an interesting lecture on the ways in which science is applied to practice. In the course of the lecture he made the following remarks on the distribution of power by electricity from a central generating station :—

Before entering further into this, let me remind you that the earliest magneto-electric machines were used nearly sixty years ago for the production of power. I will mention only Jacobi's electric launch of 1835 as an example. It must, therefore, be considered altogether erroneous to ascribe the invention of the transmission of power to an accident at the Vienna Exhibition in 1873, when, it is said, an attendant placed some stray wires into the terminals of a dynamo machine; it began to turn, and the transmission of power was first demonstrated. As a matter of fact, Sir Wm. Siemens once informed me, that his brother Werner was led to the discovery of the dynamo-electric principle by the consideration that an electro-magnetic machine behaved like a magneto-electric machine, when a current of electricity was sent into it, viz. both turn round and give out power. It was, of course, well known that a magneto-electric machine produces a current of electricity, when turned by mechanical power, and Werner concluded that an electro-magnetic machine would behave in the same manner. We all know that he was right, but I relate this circumstance only as a further proof that the generation of power by electric currents has been a well-known fact long previous to the Vienna Exhibition.

Another well-known instance of transmission of power to a distance is furnished by the magneto-electric ABC telegraph instruments, where the motion at the sending end supplies the currents necessary to move the indicator at the receiving station.

As an illustration of the distribution of power by electricity, I will briefly describe some radical alterations that have been made at the works of Messrs. Siemens Brothers and Co., by the introduction of electric motors in the place of steam engines.

[A diagram on the wall showed in outline the various buildings in which work of different kinds is carried on with the help of different machines.]

Electric motors are supplying the power, sometimes by driving shafting to which a group of tools is connected by belting, and sometimes by being coupled direct to the moving mechanism. Each section of the works has its own meter, measuring the energy that is used there, and all of them are connected by underground cables to a central station, where three sets of engines and dynamos generate the electric current for all purposes. There are two Willans and one Belliss steam engines, each of 300 horse-power, coupled direct to the dynamos, and running at a speed of 350 revolutions per minute. Room is left for a fourth set, but including some auxiliary pumps and the switchboards for controlling the dynamos and for distributing the current, the whole space occupied by 1200 horse-power measures only 32×42 feet. Close by are the condensers and three high-pressure boilers, which have replaced some low-pressure ones formerly used for some steam engines driving the machinery in the nearest building.

The advantages that have been secured by the introduction of electric motors may be briefly stated under the following heads :—

1. Various valuable spaces formerly occupied by steam engines and boilers have been made available for the extension of workshops, and these are indicated on the diagram by shading.

2. By abolishing to a great extent the mechanical transmission of power a considerable saving is effected in motive power, which is especially noticeable at times when part only of the machinery is in use.

3. As the electric motors take only as much current as is actually required for the work they are doing, a further saving is effected, and at the same time the facility with which the speed of the motors can be altered without their interfering with each other presents a feature that is absent from mechanical transmission.

4. The big steam engines being compound and condensing, produce a horse-power with a smaller consumption of fuel than the small high-pressure steam engines scattered throughout the works.

5. The numerous attendants of the old steam engines and boilers have mostly been transferred to other work, only a few of them are required at the central station, and one or two men can easily look after all the electric motors used in the various parts of the works.

Elsewhere equally favourable results have been obtained by the introduction of electrical distribution of power, and in this respect I beg to refer you to a paper read before the German Institution of Civil Engineers by Mr. E. Hartmann in April of last year, and to a paper read by Mr. Castermans before the Society of Engineers in Liège, in August last, in which he compares in detail various methods of transmission of power, of which the electrical one was adopted for a new small arms factory.

We may therefore take it for granted that the advantages alluded to above have not resulted from local circumstances at Woolwich, but that they can be realised anywhere by the adoption of the electric current for distributing power from a central station.

At first sight this result appears to be of interest only to the manufacturer; but the development of this idea may lead to far-reaching consequences, when we consider that cheap power is one of the most important requisites for cheap production.

While power was generated by steam engines the cost of producing one-horse-power varied a good deal in the different parts, and the various owners could not have obtained their power on equal terms, those possessing the largest steam engines having a distinct advantage. This inequality is done away with altogether when the power is distributed by electricity, as the current can be supplied for large or small powers at the same rate per Board of Trade unit. It is therefore clear that the establishment of central stations for the generation of electricity on a large scale will bring about the possibility of small works competing with large works in quite a number of trades where cheap power is the first consideration.

Another circumstance favouring small works is the diminution of capital outlay brought about by the employment of electric motors. Not only are the motors cheaper than boilers and steam engines of corresponding power would be, but the outlay for belting and shafts is saved, and the structure of the building need not be as substantial as is necessary where belts and shafting have to be supported by it. A commencement has already been made in this direction by the starting of electric light stations, where the owners do all in their power to encourage the use of the current in motors, in order to keep the machinery at their central station more uniformly at work. The introduction of electricity as motive power will apparently present a strong contrast to the effect steam has had on the development of industries for the reasons already stated; and in addition there are many cases where the erection of boilers and steam engines, or even of gas engines, would be inadmissible on account of want of space or of the nuisances that are inseparable from them. Motive power will therefore be available in a number of instances where up to the present time no mechanical power could be used, but the work had to be done by manual labour or not at all.

You may have noticed that I have confined my remarks hitherto to the case of distributing electricity over a limited area, but that I have not yet discussed the question of transmitting power to a great distance.

Theoretically we have been told over and over again that the motive power of the future will be supplied by waterfalls, and that their power can be made available over large areas by means of electric currents. As a prominent example the installation is constantly mentioned by which the power of a turbine at Lauffen was transmitted over a distance of 110 statute miles to the Frankfurt Exhibition with an efficiency of 75 per cent. No doubt this result is very gratifying from a purely scientific point of view, but unfortunately in practical life only commercially successful applications of science will have a lasting influence, and in this respect the Lauffen installation left much to be desired. On the one hand science tells us that the section of the conductor can be diminished as the pressure of electricity is increased, and it appears to be only necessary to construct apparatus for generating electricity at a sufficiently high pressure so as to reduce the cost of a long conductor to reasonable limits. On the other hand, experience shows that at these high potentials the insulation of the electric current becomes a most difficult problem, and for practical purposes difficulty means an increased outlay of money.

MAGNETICAL AND METEOROLOGICAL OBSERVATIONS MADE AT THE GOVERNMENT OBSERVATORY, BOMBAY, 1890, WITH AN APPENDIX.

THIS volume, we are informed, is the thirtieth of the series of "Bombay Magnetical and Meteorological Observations," extending the previous record from 1845 to 1889, up to 1890. At this well-organized observatory, under the direction of Mr. Charles Chambers, continuous registration of the different magnetical and meteorological elements is maintained by means of automatic recording instruments, of which there are five sets, the magnetographs (three), the barograph, the thermograph, the pluviograph, and the anemograph, all being photographic records excepting that of the anemograph, which is mechanical. In addition eye observations are also made, including the usual meteorological observations of weather and other phenomena. Daily values for 1890 are given of atmospheric pressure, temperature of the air, rainfall, wind and cloud, with some further discussion of the anemometric results; five day means of meteorological elements are also given. In the magnetic section is found observations of absolute horizontal force, magnetic declination and dip, at short intervals throughout the year. And in the appendix is contained a collection of the monthly values of declination and horizontal force from 1868 to 1890, accompanied by a discussion of the secular changes of these elements. In regard to declination the results show the eastern magnetic declination to have increased during the early years of the series, arriving at a maximum at about the middle of the period, and decreasing in the later years. Taking the annual values of declination to be represented by the formula $\delta = at^2 + bt + c$, it is found that the maximum easterly declination occurred in 1880, with value $0° \ 57' \ 17''$. This actual observation of the turning-point at this place, in the long cycle of change, is very interesting. The horizontal force values are similarly discussed, but in this case the values are generally progressive. There is no discussion of diurnal inequalities, but these were elaborately treated in a previous volume. Magnetic observatories in tropical and southern regions are valuable. Many exist in Europe with others scattered over different parts of the northern hemisphere, generally publishing with regularity their results, but there is a want of similar establishments in southern regions. There are magnetic observatories at Batavia, Mauritius, and Melbourne, but we do not get from them all that might be desired. England possesses no regularly maintained southern establishment of this kind. A magnetic observatory existed many years ago at the Cape of Good Hope, which, long since destroyed, we believe, by fire, was never again reorganized, which was unfortunate. The attention of the Magnetic Committee of the British Association was several years ago drawn to the question of re-establishing the Cape Magnetic Observatory, and in the Report of the Committee for the year 1891 it is stated that a representation had been made to the Admiralty as to the desirability of so doing. An efficient magnetic observatory in such a position, with regular publication of the results, would provide information of great value for the discussion of various questions in magnetic phenomena that now arise. It would be well also if the study of earth currents were taken up at some of the magnetic observatories in different parts of the world by continuous photographic registration thereof, for the better elucidation of the physical relation that may exist between magnetic and earth current variations, in regard to which our knowledge seems at present to be so imperfect.

BACTERIA AND BEER.

THE examination of water for micro-organisms since the publication by Koch in 1881 of his beautiful process of gelatine-plate cultures has come more and more into general use, as the public has gradually become cognisant of its value for hygienic and practical purposes. But whilst affording much valuable information on many subjects, Hansen has pointed out, as far back as 1888, that as applied to the examination of waters for brewing purposes it cannot be considered wholly satisfactory. Working on lines suggested by Hansen, Holm has recently published a paper, "Analyses biologiques et zymotechniques de l'eau destinée aux brasseries" (*Compte-rendu des travaux du laboratoire de Carlsberg*, vol. iii., Copenhagen, 1892), in which he describes a large number of investigations on brewing-waters examined by Hansen's method, and in which the relative merit for brewing

purposes of Koch's and Hansen's processes is also discussed. It is obvious that the organisms to be feared in a brewery are those which will flourish in wort or beer, and that the mere knowledge of the number of bacteria in any given water as revealed by gelatine plate cultures is but of little use. Hence Hansen and his pupils reject for such examinations gelatine-peptone, substituting sterilised wort and beer as a culture material. An interesting table is given showing the different bacteriological results obtained in the use of gelatine-peptone, gelatine to which wort had been added, wort alone, and beer. For example, whereas a particular brewing-water yielded by gelatine-peptone about 8000 colonies per c.c., the majority of which were bacteria; gelatine mixed with wort gave about 14, all being moulds; in wort 5·4 were found, consisting of bacteria and moulds, whilst sterilised beer gave only 0·8 for the c.c., and only moulds. Holm points out that to estimate the value of a water for brewing purposes a note should also be made of the rate at which the organisms develop in the wort or beer, for should signs of growth only declare themselves after four or five days in the laboratory under favourable conditions of temperature and in the absence of competing forms, it is not unnatural to expect that their vitality, under the more rigorous conditions imposed during brewing operations, would be so far impaired that their development, if taking place at all, would only be accomplished with great difficulty. Although instances occurred in which even after the lapse of seven days growths first made their appearance, yet in the majority of cases the incubation of the wort-flasks for one week was sufficient. Holm is of opinion that the use of other culture materials besides wort is unnecessary, as all the organisms which successfully develop in beer can also grow in wort. Moreover, it was found that in the process of sterilisation to which the beer was submitted a considerable proportion of its alcohol was lost, thus diminishing its natural bactericidal properties. A beer containing 5 to 6 per cent. of alcohol, after sterilisation, had this reduced to 2·8 per cent., although it even then proved a very unfavourable medium for the development of ordinary water bacteria. As a practical outcome of his experiments Holm emphasises the necessity of a careful selection of the site for the erection of the water-reservoir attached to a brewery. The reservoirs of the old brewery at Carlsberg are placed in the immediate vicinity of the storehouses for grain and malt, consequently in this water a far larger number of moulds were met with than in the water examined from differently situated reservoirs supplying the laboratory and another brewery. But although moulds usually predominate, yet they are not so much to be feared as the bacteria, more especially those which are found in the fermentation chamber, for although they are unable to assert themselves to any considerable extent in the beer preserved in the store cellar, yet when it is drawn off and thus aërated, and the temperature raised by its transference to bottles or small casks, these organisms can develop with an astonishing rapidity, and produce great mischief.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. Shore, of St. John's College, late Examiner in Physiology, has been elected a member of the Special Board for Medicine; Dr. A. Macalister, F.R.S., St. John's, has been appointed an elector to the Professorship of Chemistry; Dr. Ferrers, F.R.S., Master of Gonville and Caius, an elector to the Plumian Professorship of Astronomy; Prof. Newton, F.R.S., Magdalene, an elector to the Professorship of Anatomy; Dr. Phear, Master of Emmanuel, an elector to the Professorship of Botany; Dr. R. D. Roberts, Clare, an elector to the Woodwardian Professorship of Geology; Mr. P. T. Main, St. John's, an elector to the Jacksonian Professorship of Chemistry, &c.; Mr. R. T. Glazebrook, F.R.S., Trinity, an elector to the Professorship of Mineralogy; Mr. F. Darwin, F.R.S., Reader in Botany, an elector to the Professorship of Zoology and Comparative Anatomy; Mr. W. D. Niven, F.R.S., Trinity, an elector to the Cavendish Professorship of Physics; Dr. Phear, an elector to the Professorship of Mechanism; Prof. Liveing, F.R.S., St. John's, an elector to the Downing Professorship of Medicine; Dr. P. H. Pye-Smith, F.R.S., an elector to the Professorship of Physiology; and Sir G. M. Humphry, F.R.S., an elector to the Professorship of Pathology.

SCIENTIFIC SERIALS.

American Journal of Science, February.—Isothermals, isopiestics, and isometrics relative to viscosity, by C. Barus. The substance experimented upon was marine glue, and its viscosity at different pressures and temperatures was measured by a transpiration method, the substance being forced through steel tubes 10 cm. long and 0·5 to 1 cm. in diameter under pressures as high as 2000 atmospheres. It was found that in proportion as the viscosity of a body increases with fall of temperature, its isothermal rate of increase with pressure also increases. Speaking approximately, the rate at which viscosity increases with pressure at any temperature is proportional to the initial viscosity at that temperature, and, conversely, the rate of decrease with temperature is proportional to the actual temperature and independent of the pressure. An interesting result is that in high pressure phenomena at least 200 atmospheres must be allowed per degree Centigrade, in order that there may be no change of viscosity.—"Potential," a Bernoullian term, by Geo. F. Becker.—Datolite from Loughboro, Ontario, by L. V. Pirsson.—A new machine for cutting and grinding thin sections of rocks and minerals, by G. H. Williams.—Stannite and some of the alteration products from the Black Hills, S.D., by W. P. Headden.—Occurrence of hematite and martite iron ores in Mexico, by R. T. Hill, with notes on the associated igneous rocks, by W. Cross.—Cæsium lead and potassium-lead halides, by N. L. Wells.—Ceratops beds of Converse County, Wyoming, by J. B. Hatcher.—Use of planes and knife-edges in pendulums for gravity measurements, by T. C. Mendenhall. The employment of a pendulum to which the plane is attached instead of the knife-edge presents several advantages. The plane may be accurately adjusted at right angles to the rod by simple optical methods. A pendulum carrying a plane instead of a knife-edge is vastly less liable to injury, and the knife-edge being no longer an integral part of the vibrating mass can be reground or replaced at will. The length of the pendulum is more capable of accurate determination, since the error introduced by the yielding of the edge under pressure is eliminated. The disadvantage due to the uncertain position of the axis of oscillation can be mechanically got rid of by a proper construction of the raising and lowering apparatus, and experiment shows that the period in the course of twelve sets of swings of an hour each does not vary by as much as one part in a million. The best angle for the knife-edge was found to be about 130°, the material used being agate.—Preliminary note on the colours of cloudy condensation, by C. Barus. If saturated steam is allowed to pass suddenly from a higher to a lower temperature in uniformly temperatured, uniformly dusty air, a succession of colours is seen by transmitted white light which, taken in inverse order, are absolutely identical with the colours of Newton's rings of the first two orders.—Lines of structure in the Winnebago Co. meteorites and in other meteorites, by H. A. Newton (reprinted in this issue).—Preliminary note of a new meteorite from Japan, by Henry A. Ward.—Restoration of Anchisaurus, by O. C. Marsh (see Note, p. 349).

American Journal of Mathematics, vol. xiv. No. 4 (Baltimore, 1892).—The main object of the note on the use of supplementary curves in isogonal transformation, by R. A. Harris (pp. 291–300), is to show how the problem of representing one plane conformably upon another, using any real function of the variable, may be made to depend upon the problem of constructing supplementary curves from given tracings of the corresponding principal curves. It is well illustrated by four carefully drawn figures. In her memoir (pp. 301–325) on the higher singularities of plane curves, Miss C. A. Scott goes over ground to some extent previously occupied by Profs. Cayley and H. J. S. Smith in writing on the same subject (*cf.* also papers by Brill and Nöther in the *Math. Annalen*, vols. ix. xvi. xxiii.). Nöther's results are presented in analytical form, "involving no dependence on geometrical ideas even when geometrical terms are used." The author brings out his results more clearly by making use of Dr. Hirst's method of quadric inversion. The text is accompanied by twenty-seven drawings of curves. Mr. W. H. Metzler, writing on the roots of matrices (pp. 326–377), employs a modification of Dr. Forsyth's method of proving Cayley's "identical equation" ("Messr. of Mathematics," vol. xiii.) to prove Sylvester's law of latency and Sylvester's theorems. He also investigates the existence of roots of matrices for different indices, and in particular the roots of nilpotent matrices. A

careful analysis of the contents is prefixed to the memoir. Dr. F. N. Cole (pp. 378–388) discusses the simple groups from order 201 to order 500, and arrives at the conclusion that "the possible orders of simple groups of compound order between 201 and 500 are reduced to 360 and 432." The volume closes with a note (p. 389) by M. M. D'Ocagne, correcting a slight mistake in a memoir by him in the 1888 volume, entitled "Sur certaines courbes," and the title page and index.

SOCIETIES AND ACADEMIES.

LONDON.

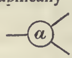
Royal Society, February 2.—"On a Meteoric Stone found at Makariwa, near Invercargill, New Zealand." By G. H. F. Ulrich, Professor of Mining and Mineralogy in the University of Dunedin, N.Z. Communicated by Prof. J. W. Judd, F.R.S.

The specimen described in this memoir was found in the year 1879 in a bed of clay, which was cut through in making a railway at Invercargill, near the southern end of the Middle Island of New Zealand. Originally, this meteorite appears to have been about the size of a man's fist, and to have weighed four or five pounds, but it was broken up, and only a few small fragments have been preserved. The stone evidently consisted originally of an intimate admixture of metallic matter (nickel-iron) and of stony material, but much of the metallic portion has undergone oxidation. Microscopic examination of thin sections shows that the stony portion, which is beautifully chondritic in structure, contains olivine, enstatite, a glass, and probably also magnetite; and through these stony materials the nickel-iron and troilite are distributed. The specific gravity of portions of the stone was found to vary between 3·31 and 3·54, owing to the unequal distribution of the metallic particles. A partial chemical examination of this meteorite was made by the author and Mr. James Allen, but the complete analysis has been undertaken by Mr. L. Fletcher, F.R.S., of the British Museum. The analysis, which when finished will be communicated to this Society, has gone so far as to show that the percentage mineral composition of the Makariwa meteorite may be expressed approximately by the following numbers: nickel-iron 1, oxides of nickel and iron 10, troilite 6, enstatite 39, olivine 44.

Physical Society, January 27.—Walter Baily, Vice-President, in the chair.—Prof. S. P. Thompson, F.R.S., made a communication on Japanese magic mirrors, and exhibited numerous specimens showing the magic properties. Referring to the theory of the subject, he said the one now generally accepted was that proved by Profs. Ayrton and Perry in 1878, who showed that the patterns seen on the screen were due to differences in curvature of the surface. The experiments he now brought forward fully confirmed their views. Brewster had maintained that the effects were due to differences of texture in the surfaces causing differences in absorption or polarisation, but the fact that the character of the reflected image depended on the convergency or divergency of the light, and on the position of the screen, showed this view to be untenable. Another proof of the differing curvature theory was then given by covering a Japanese mirror with a card having a small hole in it. On moving the card about, the disc of light reflected from the exposed portion varied in size, showing that the curvatures of portions of the surfaces were not the same. The same fact was proved by a small spherometer, and also by reflecting the light passing through a coarse grating from the mirror, the lines being shown distorted. To put the matter to a test demanded by Brewster, he had a cast taken from a mirror by his assistant, Mr. Rousseau; this had been metallised, silvered, and polished, and now gave unmistakable evidence of the pattern reflected from the original. The true explanation of how the inequalities of curvature were brought about during manufacture had also been given by Profs. Ayrton and Perry, but there were some questions of detail on which difference of opinion might exist. The late Prof. Govi had noticed that warming a mirror altered its possibilities. A thick mirror which gave no pattern whilst cold developed one on being heated, was shown to the meeting. Prof. Thompson also showed that a glass mirror having a pattern cut on the back developed magic properties when the mirror was bent. When made convex the reflected pattern was dark on a light ground, and when made concave, light on a dark ground. Warming ordinary mirror-glass by a heater whose surface was cut to a pattern gave similar effects. Very thick glasses could be affected in this way. On passing a spirit lamp behind a strip of mirror, a dark band could be caused to pass along the screen illuminated by light reflected from the mirror. By writing on lead foil and pressing the foil against a glass mirror by a heater, the writing was caused to appear on the screen. Prof. Thompson had also found that Japanese mirrors which are not "magic" when imported, could be made so by bending them mechanically so as to make them more convex. In conclusion, he showed a large mirror 15″ × 11″, the reflection from which showed the prominent parts of the pattern on its back with the exception of two conspicuous knobs; these knobs gave no indication of their existence. Prof. Ayrton said the simple mechanical production of the magic property described by Prof. Thompson led him to think that some experiments on "seeing by electricity" by the aid of selenium cells which Prof. Perry and himself made some years ago, might lead to some result if repeated with thinner reflectors. Speaking of the effect of scratching the back of a Japanese mirror, he pointed out that if metal be removed by pressure a bright image was seen, whilst if removed chemically a dark image resulted. Since the original paper on the subject was written he had been led to modify his views as to the effect of amalgamation, for some time ago he showed the society how brass bars were bent if one edge be amalgamated, thus proving that enormous forces were developed. He now regarded amalgamation as an important part of the manufacture. Mr. Trotter inquired if it had been proved that there was no difference in the metal in the thick and thin parts? One would expect the thin parts to be harder and polished away less. After some remarks by Mr. J. W. Kearton and Major Rawson, Prof. Thompson said the magic effects produced by heating the back of a glass mirror remained for a short time after the heater was removed. The question of whether differences in hardness of the thick and thin parts of a mirror were of consequence in the production of the magic property had been tested by using sheets of brass thickened by pieces soldered to the back as mirrors, and found to be unimportant. Prof. Ayrton also described an experiment pointing to the same conclusion.—Mr. W. F. Stanley read a paper on the functions of the retina—(i.) The Perception of Colour. Referring to Young's three-nerve theory of colour-sensation, the author said Prof. Rutherford had pointed out that there was no necessity to assume that different nerves conveyed different colour-sensations, for as a telephone wire would transmit almost an infinite variety of sound vibrations, so the nerves of the retina were probably equally capable of conveying all kinds of light vibrations. Prof. Rutherford had further pointed out that the image of a star could not possibly cover three nerve-terminals at once, and therefore could not be seen as white if Young's theory was correct. The author then described Helmholtz's experiments with a small hole in a screen illuminated by spectrum colours. For red illumination the greatest distance at which the hole could be seen sharply defined was 8 feet, and for violet 1½ feet. When the hole was covered with purple glass, or with red and violet glasses superposed, and a bright light placed behind, the eye, when accommodated for red light, saw a red spot with a violet halo round it, and when focussed for violet light, saw a violet spot with circle of red. These experiments the author thinks show that the chromatic sense in distinct vision under critical conditions (*i.e.* where a single nerve or a small group of nerves is concerned) depends on the colours being brought to foci at different distances behind the crystalline lens. He also infers that the same focal position in the eye cannot convey simultaneously the compound impression of widely separated colours. Helmholtz's observations are further examined in the paper, and a series of zoetrope and colour disc experiments described which tend to show that the eye cannot follow rapid changes of colour. Changes from red to violet could be followed much more quickly than from violet to red. The red impressions were, however, more permanent. The observed effects were found to depend on the intensity of the light, and also on the distance of the eye from the coloured surface. Summing up his observations, the author infers that by systems of accommodation of the eye, the colours of the spectrum are brought to focus on special parts or points of the rods or cones of the retina, such focal points being equivalent, by equal depths or distances from the crystalline lens, to a focal plane formed across the whole series of nerve-terminals. That all the rays of light from an object, or part of an object, of very small area and of any spectrum colour, will converge to

a point upon a nerve terminal, and that this terminal will be most excited by the light. At the end of the paper Dr. Stanley Hall's views of nerve structure are examined. Captain Abney thought the results of the zoetrope experiments were what one would have expected when pigmentary colours were used. To be conclusive, such experiments must be conducted with pure spectrum colours. The statement about the size of star images being less than that of a nerve terminal would probably need revision. Speaking of colour vision, he said the modern view was to regard light as producing chemical action in the retina, which action gave rise to the sensation of colour. On the author's theory he could not see how colour-blindness could be explained. Mr. Trotter said he understood Helmholtz to have proved that nerves could distinguish quantity, but not the quality of a stimulus. Since the speed at which stimuli travelled to the brain was about 30 metres a second, the wave length of a light vibration, if transmitted in this way, would be very small. Taking Lord Kelvin's estimate of the minimum size of molecules of matter, it followed that there must be many wave lengths in the length of a single molecule. This, he thought, hardly seemed possible. Mr. Lovibond pointed out that the observations referred to by the author could be equally well explained on the supposition that six colour sensations existed. The confusion of colours he had mentioned arose from lack of light. Mr. Stanley replied to some of the points raised by Captain Abney. In proposing a vote of thanks to Mr. Stanley, the chairman said it had been shown that light could be resolved into three sensations, but it was not known how this resolution occurred. Prof. S. P. Thompson said the gist of Mr. Stanley's paper seemed to be that lights of different colours were concentrated at points situated at different depths in the retina, the violet falling on the part nearest the crystalline lens, and the red furthest away. Another view of the action was that the different sensations might be due to the vibrations of longer wave length having to travel greater distances along the nerve terminals before they were completely absorbed.

Mathematical Society, January 12.—Mr. A. B. Kempe, F.R.S., President, in the chair.—The President (Prof. Elliott, F.R.S., Vice-President, in the chair) read a paper on the application of Clifford's graphs to ordinary binary quantics (second part). In the first part it was pointed out that by some small modifications and a recognition of the fact that the covariants of $f(x, y)$ are invariants of the two quantics $f(X, Y)$ and $(Xy-Yx)$, the theory of graphs, which had been left in an unfinished state by the late Prof. Clifford, furnished a complete method of graphically representing the invariants (and therefore the covariants) of binary quantics. The method as modified depends essentially on the fact that any invariant, when multiplied by a suitable number of polar elements U, U′, V, V′, &c., can be expressed as a "pure compound form" (or sum of two or more such forms), the product of a number of "simple forms." Each of the latter has a "mark," viz. one of the letters $a, b, c, \ldots\ldots$ and has also a certain valence, 0, 1, 2, 3, &c. and these being given it is fully defined, *e.g.*, the simple form of mark a and valence 3 is graphically



having three radiating bonds, and is algebraically

$$a_0\,UVW + a_1\,(U'VW + UV'W + UVW') + a_2\,(UV'W' + U'VW' + U'V'W) + a_3\,U'V'W',$$

the pairs of polar elements U, U′; V, V′; and W, W′, corresponding to the three bonds of the graphical representation. A pure compound form is graphically represented by a number of simple forms having their bonds connected so that there are no free ends. If in the algebraical expression of a compound form two simple forms both contain the pair of polar elements U, U′, there will be a bond connecting their graphical representations; if the two simple forms both contain two pairs of such elements, viz. U, U′ and V, V′, there will be two bonds connecting their graphical representations and so on; if they contain no common pair their graphical representations will have bond connecting them. A pair of polar elements will appear in two simple forms only, so that each bond in the graphical representation of a compound form corresponds to a distinct pair of polar elements. If the algebraical expression corresponding to a graph be multiplied out, it will be found to consist of two distinct factors, viz.:—(1) the product of all the polar elements, and (2) a function of the letters $a_0, a_1, a_2 \ldots\ldots$; $b_0, b_1, b_2, \ldots\ldots$; &c., &c.; corresponding to the marks $a, b, \ldots\ldots$&c. of the simple forms contained in the compound form represented by the graph, the latter factor being an invariant of the quantics

$$\begin{gathered}(a_0, a_1, a_2, \ldots\ldots\ldots a_\alpha)(x, y)^\alpha\\ (b_0, b_1, b_2, \ldots\ldots\ldots b_\beta)(x, y)^\beta\\ \text{\&c., \&c.}\end{gathered}$$

where α is the valence of the simple forms of mark a, which are here supposed to be all of the same valence, and similarly in the case of β, γ, &c.

In this second part a method of algebraically representing invariants is considered, which is directly derivable from the method of the first part, and was suggested by the graphs; but differs essentially from the earlier method in that it is independent of the use of polar elements. It shows, moreover, that the graphs may be regarded as absolutely equivalent to the invariants they represent, in lieu of being equivalent to those invariants multiplied by a number of polar elements. This second method deals in the first instance with "primary" invariants, *i.e.* invariants of two or more quantics linear in the coefficients of each. If these quantics are

$$\begin{gathered}(a_0, a_1, a_2, \ldots\ldots\ldots a_\alpha)(x, y)^\alpha\\ (b_0, b_1, b_2, \ldots\ldots\ldots b_\beta)(x, y)^\beta\\ \text{\&c., \&c.,}\end{gathered}$$

and we take

$$a = a_1\frac{d}{da_0} + a_2\frac{d}{da_1} + a_3\frac{d}{da_2} + \text{\&c. } \textit{ad infinitum}$$

$$b = b_1\frac{d}{db_0} + b_2\frac{d}{db_1} + b_3\frac{d}{db_2} + \text{\&c. } \textit{ad infinitum.}$$

&c., &c.

we may express any primary invariant by an expression, or the sum of two or more expressions, consisting of the product of differences of the operators $a, b, \ldots\ldots$ operating upon the product of the corresponding leading terms, a_0, b_0, &c. Thus

$$(a-b)^2 a_0 b_0 \equiv a_2 b_0 - 2a_1 b_1 + a_0 b_2$$

is an invariant of the two quantics

$$\begin{gathered}a_0x^2 + 2a_1xy + a_2y^2,\\ b_0x^2 + 2b_1xy + b_2y^2,\end{gathered}$$

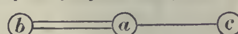
linear in the coefficients of each; and

$$(a-b)^2(a-c)a_0b_0c_0 \equiv a_3b_0c_0 - a_2b_0c_1 - 2a_2b_1c_0 + 2a_1b_1c_1 + a_1b_2c_0 - a_0b_2c_1$$

is a similar invariant of the three quantics

$$\begin{gathered}a_0x^3 + 3a_1x^2y + 3a_2xy^2 + a_3y^3\\ b_0x^2 + 2b_1xy + b_2y^2\\ c_0x + c_1y.\end{gathered}$$

These two invariants are graphically represented by

 and 

respectively, where the relation between the algebraical and graphical expressions is obvious, viz. to every letter p in the algebraical representation there corresponds a nucleus including the mark p, and to every factor $(p-q)$ in the algebraical representation there corresponds a bond connecting the nuclei of marks p and q.

We can pass to invariants of higher degrees in the coefficients of the various quantics by substituting like coefficients for unlike. Thus, if we make $b_0 = a_0$, $b_1 = a_1$, $b_2 = a_2$, the primary invariant

$$a_2b_0 - 2a_1b_1 + a_0b_2$$

becomes the invariant of degree 2

$$2(a_0a_2 - a_1^2)$$

of the single quantic

$$a_0x^2 + 2a_1xy + a_2y^2.$$

This invariant will be graphically represented by substituting the mark a for the mark b in the graph representing the corresponding primary invariant.

If we proceed to deal in the same way with the invariant,

$$a_3b_0c_0 - a_2b_0c_1 - 2a_2b_1c_0 + 2a_1b_1c_1 + a_1b_2c_0 - a_0b_2c_1,$$

we get, as the invariant represented by substituting for the marks b and c the mark a, the expression of the third degree,

$$a_3a_0^2 - 3a_2a_1a_0 + 2a_1^3.$$

This is not an invariant of a single quantic, but of the three

$$a_0x^3 + 3a_1x^2y + 3a_2xy^2 + a_3y^3$$
$$a_0x^2 + 2a_1xy + a_2y^2$$
$$a_0x + a_1y.$$

It bears, however, a definite relation to the first of these three quantics, viz.: it is a *seminvariant* of that quantic, being in fact the source of its cubic-covariant J. The paper points out that all seminvariants are thus invariants of two or more quantics, and can therefore be represented by graphs; the difference between a graph representing an invariant of a quantic and one representing a seminvariant of the same quantic consisting merely in this, that the simple forms, *i.e.* the small circles or nuclei of the graphs in the former case are all of the same "valence," *i.e.* have the same number of bonds, while in the latter, though of like marks, they differ in valence. The classification of seminvariants, according to the valences of the simple forms composing them, or, in other words, according to the orders of the quantics of the systems of which they are respectively invariants, obviously throws considerable light upon their structure.

The paper also deals with the breaking up of graphs into simpler ones; and gives a theorem upon the subject which leads to some interesting results. It points out, moreover, how the graphs representing the sources of covariants can be instantaneously derived from those representing the covariants themselves.

On the evaluation of a certain surface-integral and its application to the expansion of the potential of ellipsoids in series, Dr. Hobson.

On the vibrations of an elastic circular ring, by Mr. A. E. H. Love.—The ring is supposed to be of small circular section of radius c, and the elastic central-line a circle of radius a. There are four ways of displacing the ring. A point on the central-line may move along the radius of the circle which is its primitive form, or perpendicular to the plane of this circle, or along the tangent to this circle; and the circular sections may be displaced by rotation about the central-line. The modes of vibration fall into four classes, of which two are physically important:—Class I. Flexural vibrations in plane of ring.—These were investigated by Hoppe in 1871 (*Crelle*, bd. lxxiii.). The motion of a point on the elastic central-line is compounded of a displacement in and out along the radius and a displacement along the tangent to the circle, so proportioned that the central-line remains unstretched, and the nodes of the former displacement are the antinodes of the latter. There must be at least two wave-lengths to the circumference, and the frequency ($p/2\pi$) of the mode in which there are n wave-lengths to the circumference is given by the equation

$$p^2 = \tfrac{1}{4}\,\frac{n^2(n^2-1)^2}{n^2+1}\,\frac{E}{\rho_0}\,\frac{c^2}{a^4}$$

in which E is the Young's modulus, and ρ_0 the density of the material. Except for the numerical coefficient this is precisely similar to the formula for the lateral vibrations of a straight bar of the same material and section and of length πa (for which the fundamental tone has the same wave-lengths). The sequence of component tones when n is very great is ultimately identical with that of the tones of a free-free bar of length πa, but the sequence for the low tones is quite different to that for a bar. Class II. Flexural vibrations perpendicular to the plane of the ring.—It is found to be impossible to make the ring vibrate freely so that each particle of the elastic central-line moves perpendicular to the plane of the ring, unless at the same time the sections turn about the central-line through a certain angle. The flexure perpendicular to the plane of the ring is always accompanied by *torsion*. As in Class I. there must be at least two wave-lengths to the circumference, and the frequency of the mode in which there are n wave-lengths to the circumference is given by the equation

$$p^2 = \tfrac{1}{4}\,\frac{n^2(n^2-1)^2}{1+\sigma+n^2}\,\frac{E}{\rho_0}\,\frac{c^2}{a^4}$$

where σ is the *Poisson's ratio* for the material and the other constants have the same meaning as before. (For most hard solids σ is about $\frac{1}{4}$.) Since n must be at least 2 the sequence of tones is very nearly the same as in the vibrations of Class I., but the pitch is slightly lower, the ratio of the frequencies for the gravest tones being $\sqrt{\frac{21}{20}}$, which is very little less than a *comma*. For the higher tones, as we should expect, there is no sensible difference. These two classes include all that have much physical importance. The remaining types can be classified as:—Class III. Extensional vibrations.—The motion may be purely radial or partly radial and partly tangential. In the second case there will be an integral number of wave-lengths, and when this number is n we have the formula for the frequency

$$p^2 = (1 + n^2)\,\frac{E}{\rho_0}\,\frac{1}{a^2}$$

Putting n = zero we find the frequency of the purely radial vibrations. The pitch of any mode of extensional vibration of the ring is of the same order of magnitude as the pitch of the corresponding longitudinal vibration of a bar of length equal to half the circumference, the formula for the latter being in fact derived by writing n^2 for $1 + n^2$. Class IV. Torsional vibrations.—The motion consists of an angular displacement of the sections about the elastic central-line accompanied by a relatively very small displacement of the points on this line perpendicular to the plane of the ring. When there are n wave-lengths to the circumference the frequency is given by the formula

$$p^2 = (1 + \sigma + n^2)\,\frac{\mu}{\rho_0}\,a^2,$$

in which μ is the *rigidity* of the material. There is one symmetrical mode for which n is zero, and since $2\mu(1+\sigma) = E$, the frequency of this mode is $\frac{1}{2}\sqrt{2}$ of that of the radial vibrations. The pitch of the torsional vibrations is comparable with that for a straight rod of length equal to half the circumference, the formula for the latter being in fact derived by writing n^2 in place of $1 + \sigma + n^2$. Formulæ equivalent to those given in connection with Classes II. and IV. have been obtained by Mr. Basset (Proc. Dec. 1891), but he has not interpreted his results.

Entomological Society, February 8.—Mr. Henry John Elwes, president, in the chair.—The President announced that he had nominated Mr. F. DuCane Godman, F.R.S., Mr. Frederic Merrifield, and Mr. George H. Verrall as Vice-Presidents during the Session 1893–1894.—Mr. S. Stevens exhibited a specimen of *Chærocampa celerio*, in very fine condition, captured at light, in Hastings, on September 26 last, by Mr. Johnson.—Mr. A. J. Chitty exhibited specimens of *Gibbium scotias* and *Pentarthrum huttoni*, taken by Mr. Rye in a cellar in Shoe Lane. He stated that the *Gibbium scotias* lived in a mixture of beer and sawdust in the cellar, and that when this was cleaned out the beetles disappeared. The *Pentarthrum huttoni* lived in wood in the cellar.—Mr. McLachlan exhibited a large Noctuid moth, which had been placed in his hands by Mr. R. H. Scott, F.R.S., of the Meteorological Office. It was stated to have been taken at sea in the South Atlantic, in about lat. 28° S., long. 26° W. Colonel Swinhoe and the President made some remarks on the species, and on the migration of many species of Lepidoptera.—Mr. W. F. H. Blandford exhibited larvæ and pupæ of *Rhynchophorus palmarum*, L., the Gru-gru Worm of the West Indian Islands, which is eaten as a delicacy by the Negroes and by the French Creoles of Martinique. He stated that the existence of post-thoracic stigmata in the larva of a species of Rhynchophorus had been mentioned by Candèze, but denied by Leconte and Horn. They were certainly present in the larva of *R. palmarum*, but were very minute.—Mr. G. T. Porritt exhibited two varieties of *Arctia lubricipeda* from York; an olive-banded specimen of *Bombyx quercus* from Huddersfield; and a small melanic specimen of *Melanippe hastata* from Wharncliffe Wood, Yorkshire.—Mr. H. Goss exhibited species of Lepidoptera, Coleoptera, and Neuroptera, sent to him by Major G. H. Leathem, who had collected them, last June and July, whilst on a shooting expedition in Kashmi territory, Bengal. Some of the specimens were taken by Major Leathem at an elevation of from 10,000 to 11,000 feet, but the majority were stated to have been collected in the Krishnye Valley, which drains the glaciers on the western slopes of the Nun Kun range. Mr. Elwes remarked that some of the butterflies were of great interest.—Mr. G. F. Hampson exhibited a curious form of *Parnassius*, taken by Sir Henry Jenkyns, K.C.B., on June 29 last, in the Gasternthal, Kandersteg.—Mr. J. M. Adye exhibited a long series of remarkable varieties of *Boarmia repandata*, taken last July in the New Forest.—Mr. C. O. Waterhouse exhibited a photograph of the middle of the eye of a male *Tabanus*, showing square and other forms of facets, multiplied twenty-five times.—Mr. R. Trimen, F.R.S., communicated a paper entitled "On some new, or imperfectly known, species of South African

Butterflies," and the species described in this paper were exhibited.—Mr. T. D. A. Cockerell communicated a paper entitled "Two new species of *Pulvinaria* from Jamaica."—Mr. Martin Jacoby communicated a paper entitled "Descriptions of some new genera and new species of Halticidæ."

Linnean Society, February 2.—Prof. Stewart, President, in the chair.—On behalf of Mr. Thomas Scott, the Secretary read a report on the entomostraca from the Gulf of Guinea, collected by Mr. John Rattray.—Mr. H. Bernard gave an account of two new species of *Rhax*.—An important paper by Mr. Arthur Lister, on the division of nuclei in the mycetozoa, gave rise to an interesting discussion, in which Dr. D. H. Scott, Prof. Howes, and others took part.—This was followed by a paper on the structural differentiation of the protozoan body as studied in microscopic sections, by Mr. J. E. Moore. The meeting adjourned to February 16.

Paris.

Academy of Sciences, February 6.—M. de Lacaze-Duthiers in the chair.—On the variations in the intensity of terrestrial gravitation, by M. d'Abbadie. Observations begun in 1837 at Olinda (Brazil), on the variations in the direction of gravitational force also made its constancy doubtful. Experiments on falling bodies revealed irregularities similar to those described (last number) by M. Mascart. The closed barometer employed by the latter may be termed a *brithometer*.—On the preparation of carbon under high pressure, by M. Henri Moissan (see article).—On the reproduction of the diamond, by M. C. Friedel. Remarks by M. Berthelot (see article).—On the pathogeny of diabetes; part played by the expenditure and the production of glycose in the deviations of the glycemic function, by MM. A. Chauveau and Kaufmann. The same inferiority of venous with respect to arterial blood, as regards the amount of sugar contained in it, occurs in all the deviations of the glycemic function produced by a lesion of the central nervous system. This inferiority is equally pronounced in the hyperglycemia resulting from the extirpation of the pancreas.—On the progress of the art of surveying with the aid of photography, in Europe and America, by M. A. Lausedat. Since 1888 a zone of twenty miles on each side of the Canadian Pacific Railway, in the neighbourhood of the Canadian National Park, has been surveyed with the aid of photography under the direction of Messrs. Deville, Drewry, and McArthur, at an average rate of 1040 square km. per annum for four men under great climatic disadvantages. The cost of the undertaking amounts to three dollars per square km.—Determination of the amount of carbonic oxide which can be contained in confined air, by means of a bird employed as physiological reagent, by M. N. Gréhant.—On the properties of faculæ; reply to a note by Mr. G. Hale, by M. H. Deslandres.—The probability of coincidence between solar and terrestrial phenomena, by M. G. E. Hale.—Note on an explicit expression of the algebraic integral of a hyperelliptic system of the most general form, by M. F. de Salvert.—On a generalisation of Bertrand's curves, by M. Alphonse Dumoulin.—On the surfaces which admit a system of lines of spherical curvature and which have the same spherical representation for their lines of curvature, by M. Blutel.—On semicircular interference fringes, by M. G. Meslin. Rectilinear interference fringes are sections of hyperboloids by planes parallel to their axis, the light being propagated in a direction at right angles to that axis. If the light proceeds along the axis, a screen perpendicular to it will cut circular sections, and the fringes will have the form of a circumference of which a greater or smaller arc will be seen accordingly as the two pencils overlap more or less. In practice these circular fringes were obtained by separating two of Bellet's half lenses and placing them one before the other in front of a very small hole illuminated by sunlight, such that the axis of the pencil passes through the optical centre of the two lenses. Under these conditions two pencils are formed from the same source of light, which may be made to show circular fringes by moving the lenses slightly in a direction perpendicular to their optical axes.—Study of the fluorides of chromium, by M. C. Poulenc.—On a new soldering process for aluminium and various other metals, by M. J. Novel. For aluminium the following solders are recommended: (1) Pure tin, fuses at 250°. (2) Pure tin 1000 gr.; lead 50 gr. (280° to 300°). (3) Pure tin 1000 gr.; pure zinc 50 gr. (280° to 320°). These solders do not stain or attack aluminium. A nickel soldering bit is preferable. (4) Pure tin 1000 gr.; red copper 10 to 15 gr. (350° to 450°). (5) Pure tin 1000 gr.; pure nickel 10 to 15 gr. (350° to 450°). These give a slightly yellowish tint, but are very durable. (6) Pure tin 900 gr.; copper 100 gr.; bismuth 2 to 3 gr. This is specially suitable for soldering aluminium bronze.—Action of acetic acid and formic acid upon terebenthine, by MM. Bouchardat and Oliviers.—On the mode of elimination of carbonic oxide, by M. L. de Saint-Martin. Experiment shows that animals partly intoxicated by carbonic oxide, when placed in conditions under which natural elimination is impossible, destroy slowly but regularly a certain quantity of the poisonous gas, this destruction being the more active the less the intoxication. It is probably converted into carbon dioxide. The toxic effect is entirely dependent upon the time during which the organism is exposed to the gas, and a very small quantity can be fatal on prolonged exposure.—Influence of pilocarpine and floridzine on the production of sugar in milk, by M. Cornevin.—On the seat of the colouring matter in the green oyster, by M. Joannes Chatin.—On pseudo-fertilisation in the *Uredinei*, by MM. P. A. Dangeard and Sapin-Trouffly.—On the substances formed by the nucleole in *Spirogyra setiformis*, and the directive force which it exerts upon them at the moment of the division of the cellular nucleus, by M. Ch. Decagny.—On a process for measuring the double refraction of crystalline plates, by M. Georges Friedel.—A horizontal section of the French Alps, by M. W. Kilian.—On the arrangement of the cretaceous beds in the interior of the Aquitaine basin, and their relations to tertiary formations, by M. Emmanuel Fallot.

CONTENTS.

THURSDAY, FEBRUARY 23, 1893.

MAN AND EVOLUTION.

Evolution and Man's Place in Nature. By Henry Calderwood, LL.D., F.R.S.E., Professor of Moral Philosophy, University of Edinburgh. (London: Macmillan and Co., 1893.)

THIS work appears to have been written for the purpose of setting forth the author's views as to the twofold nature and origin of man. He admits, fully and unreservedly, that both the bodily organism and the lower mental nature of man have alike been developed by a process of evolution from a lower animal form; but he urges with much force, and often with both eloquence and dialectic skill, that the rational and moral nature of man has not been thus developed.

The book, however, has many defects; and one cannot but feel that the writer has undertaken a task somewhat beyond his powers. Most prominent is its extreme diffuseness and vagueness, the want of systematic treatment, the frequent reiteration of the same ideas under different forms of words, and the misconceptions arising from want of familiarity with many of the subjects discussed. We are also annoyed by the frequent reference to problems to be discussed or solved, which are yet only hinted at or talked about later on. Thus, in the first chapter, we are told that a "fuller study of human life" is now required, and that the crowning effort of science in the study of Nature must be "the solution of the problem of man's appearance" on earth. Yet no attempt is made in the whole volume, either to solve this problem or even to show what progress has been made towards solving it. At p. 154 we are told that—"We are now ready for consideration of Darwin's argument"—as to the relation of the mental nature of man and the lower animals. And on the next page—"The direction to be followed now becomes more obvious"—after which we have pages of general remarks on the intelligence of the dog and the ant. Then, at p. 162—"The method to be followed is clear: we must compare the higher animals with man"—and —"careful comparison of the two orders of life is the only course open for scientific inquiry," and again,—"The difficulties belonging to such a mode of inquiry are many; but no easier method is available." Then, at p. 167, we find that Darwin "has at least suggested the essential conditions of our inquiry." After this we have another series of vague general remarks, till at p. 171 we find another statement of the mode of inquiry, and we are told that "we must have in full view all that is common to man, as animal, with the higher mammals, making account of close approximation in organic structure." Yet we nowhere find any attempt to apply these principles or methods so laboriously set forth, but are put off with such statements as—"In proof of exercise of intelligence, examples are many and familiar, making it unnecessary to enter upon detailed references." Then we are interrupted by fifteen pages of remarks on instinct among insects, although it has been repeatedly stated that the relation of man to the higher animals was the problem to be discussed; and at p. 193, we are told that—"Now at length, after careful survey of lower levels, we advance towards the height, on which the grand problems of intelligence become visible. Study of comparative intelligence now becomes possible." Then follow again page after page of what can only be described as "general remarks" on horses, dogs, monkeys, and other animals. We are told, for example—"When the higher animals are compared with the lower, it is clear that a power of intelligence must be attributed to the higher, which cannot be credited to the lower. Phenomena of domestication come to our aid here, confirming this generalisation." And a little further on, as a proof that dogs can interpret signs and act upon them, we have the following concrete illustration, among the very few in the book, and therefore we may presume it is considered a valuable one. "'Go home' will send one dog back, but the Gaelic equivalent alone will be effective in the case of a dog reared in the Highlands of Scotland, where the Celtic tongue is in common use." And then, as if the intelligent reader might doubt this astounding fact, the author adds, "Observation affords ample testimony for this."

Although the author has evidently read very widely on the subject of evolution, his want of grasp of the subject is continually shown. Thus, when discussing the struggle for existence, he seems to think that this is usually considered to be limited to a struggle for food. He says:—"A general view of the relations of life and environment will guard against interpretation of facts exclusively by reference to struggle for existence consequent on the relations of numbers to food-supply." . . . "Life is too rich in variety to find adequate explanation of its history in the mere balancing of our numbers with food-supplies." . . . "In no life is progress to be explained exclusively by reference to amount of food-supply" . . . "environment must be read much more largely than could be suggested by mere dependence on materials for nutriment" —the above passages all occurring in a single paragraph.

We have to thank the author, however, for the very clear manner in which he admits, and even enforces the application of evolution to man. He states this conclusion in several places. Thus, at page 261, we find the following:—

"The novelty of the situation lies in this, that man's alliance with all animal life has been established with a clearness and fulness of representation never before possible in the history of the world. The long-hidden secrets of nature are disclosed, and, behold! man has his heritage among the beasts of the field. The discovery is indeed a large one; the demonstration has been worked out in minute detail till no place is left for doubt."

By far the best portion of the work is that which is its special feature—the discussion of the rational as contrasted with the mere perceptive and intelligent nature of man and of the lower animals. A few quotations will explain the author's views, and show him at his best.

"The conditions of action are changed when rational self-direction comes into view. This change is so great as to amount to a complete contrast with all that has appeared in lower forms of life. Passion and appetite have not disappeared: they are present as before; but instead of determining conduct, a new exercise of power has appeared to control them. Life has here a duality within it, which has not been seen at any lower stage.

Life's history becomes in this way a history of conflict, of which no trace has appeared at any earlier point in natural history. The struggle between individuals has not disappeared, but a struggle within the individual life occurs, which has never been visible in the history of any inferior order of life" (p. 55).

Another aspect of the rational nature is thus defined :—

"The difference which severs man from the animals lies beyond the craving, and the cunning, and the consuming of what has been captured. We trace it in his plans for the day, in his preparation of his weapons, in his survey of the heavens, in his taking of reckonings for direction. He deals with the relations of means to ends ; he utilises past experience in his reflections over what has happened ; he reaches general conclusions" (p. 270).

Perhaps the finest passage in the book is at p. 287, tracing the moral element in the thought of all kinds of men and all diversities of race, as shown by the sense of wrong and injustice. We can only give here the concluding lines :—

"To this appeals the criminal in the heart of our surging crowds, placed under arrest, if he should be condemned on insufficient evidence. To this appeals every buyer in the market, defrauded by the thrusting of adulterated goods into his hands. And to this does every gentle one make appeal, defrauded in ways still worse, by false expressions of love, from whose falseness recoils a blighted life, bearing through long and weary years witness to the cruel wrong that has been done. Where, along the devious paths in which man is found, is justice not honoured, at least by outcry against harsh wrongs?"

There is much in this volume that will attract readers more disposed towards the esthetical and moral than towards the scientific aspects of evolution. Agreeing, as the present writer does, with most of the conclusions of the author, he can but regret that they have not been set forth in a manner more likely to attract scientific readers.

A. R. W.

POINCARÉ'S "THÉORIE MATHÉMATIQUE DE LA LUMIÈRE."

Théorie Mathématique de la Lumière. Par H. Poincaré, Membre de l'Institut. (Paris: G. Carré, 1889 and 1892.)

THIS work consists of two volumes, the first of which comprises a course of lectures delivered by the author in 1887–1888, whilst the second contains a further course delivered in 1891–1892.

The first volume commences with a discussion of the constitution of the luminiferous ether, in which the latter is regarded as a system of discret molecules in stable equilibrium under the action of molecular forces, and the author finally deduces equations of motion of the same form as those which are furnished by the ordinary theory of isotropic elastic media. He then adopts the hypothesis, originally due to Lord Kelvin, that the velocity of propagation of the longitudinal wave is practically zero. The principle of Huygens is next dealt with, and this is followed by a chapter on diffraction. A complete discussion of all the difficulties attending the resolution of waves would carry us too far, but the author does not appear to be acquainted with the masterly investigation of Sir G. Stokes, or the formula deduced by him, which gives the effect of an element of a plane wave at a distant point, and which enables the unsatisfactory reasoning on which the principle of Huygens depends to be dispensed with. The diffraction of light diverging from a focus is next discussed, and the intensity of light diffracted by a circular aperture or disc is obtained in the particular case in which the point of observation is the projection of the centre of the aperture or disc upon a screen ; but no mention is made of Prof. Lommel's able investigation in the general case of an excentric point. A few stock problems relating to the diffraction of parallel rays are also discussed, but nothing is said about the resolving power of optical instruments, or the theory of gratings, including Prof. Rowland's ingenious invention of concave gratings.

Chapter V. commences with the theories which have been proposed to explain the photogyric properties of quartz and certain organic substances, and concludes with an account of some of the theories of *ordinary* dispersion. This is followed by a long chapter which begins with Fresnel's theory of double refraction, and then proceeds to discuss the theories of Cauchy, Neumann, Sarrau and Bousinesq.

In all these theories the ether is regarded as an æolotropic elastic medium, and in considering them the author is to be congratulated on having shown no sympathy with the small minority who regard the writing down of equations as a foolish process ; but although during recent years much time has been spent in elaborating such theories, it may be questioned whether the majority of them have contributed any very substantial addition to scientific knowledge. The theory of the propagation of waves in an æolotropic elastic medium was rigorously investigated by Green as long ago as 1839 ; and although a theory of this kind is useful in enabling the mind to form a mental representation of the mechanism which is required to produce double refraction, it is well known that Green's theory, and all others of a similar character, fail to furnish a satisfactory explanation of this phenomenon. The principal defects of such theories are, that although most of them lead to Fresnel's wave surface, or to one which is a very close approximation thereto, they require us to suppose that the vibrations of polarized light are parallel instead of perpendicular to the plane of polarization ; and they also fail to give results which explain crystalline reflection and refraction, unless certain additional assumptions of a very questionable character are made. Probably it will not be thought an exaggeration to say, that the only theory of elastic media which satisfactorily explains double refraction is the one which is due to the joint labours of Lord Rayleigh, Lord Kelvin, and Mr. Glazebrook.

At the commencement of Chapter VII., which deals with reflection, the following statement is made (see p. 320) :—

"La réflexion vitreuse a donné lieu à trois théories également confirmé par l'expérience, ce sont celle de Fresnel, celle de Neumann et MacCullagh et celle de Cauchy."

The theories of Neumann and MacCullagh depend upon the hypothesis that the *density* of the ether is the same in all media, and that it is the rigidity which

varies; and it is somewhat surprising that M. Poincaré does not appear to be aware of the investigations of Lorenz and Lord Rayleigh, who completely exploded this hypothesis twenty years ago by showing that it leads to two polarizing angles. The weak point in the investigations of most French mathematicians on the subject of reflection and refraction arises from the fact that, in consequence of their not having made a careful study of Green's papers and the subsequent developments by Lord Rayleigh and Lord Kelvin, they are unable to deal satisfactorily with the longitudinal or pressural wave. The difficulties arising from the existence of these waves may be got rid of either by assuming, as Green did, that the ratio of the velocity of propagation of the longitudinal wave to that of the transverse wave is very large, or, by adopting Lord Kelvin's hypothesis, that the above ratio is very small; but it cannot be too emphatically stated that the existence of such waves must not be disregarded, and that any attempt to ignore them will inevitably end in failure.

This chapter concludes with a brief account of metallic reflection, in which the author has adopted the equations of motion given by Voigt. The chief difficulty in trying to explain metallic reflection, by the introduction of a viscous term into the equations of motion, is due to the fact that Eisenlohr has shown that for certain metals the pseudo-refractive index is a complex quantity whose real part is negative.

Turning now to Volume II., which consists of a further course of lectures delivered in 1891–1892, we find that it commences with the theory of isotropic elastic media in its ordinary form. Next follows a chapter on the electromagnetic theory, in which the author confines himself to the case of an isotropic medium, and has given no account of the investigations of Glazebrook on crystalline reflection and refraction, in which it is shown that the intensities of the reflected and refracted waves satisfy the same equations as those deduced many years previously by MacCullagh from an erroneous theory, but which nevertheless explain the facts in a fairly satisfactory manner. M. Poincaré assumes that the vector potential satisfies the solenoidal condition; but although the employment of the vector potential is valuable as a mathematical artifice, its use requires extreme care, inasmuch as it contains an undetermined quantity; and I believe it can be proved that in certain cases the solenoidal condition is not satisfied. In the electromagnetic theory of light this difficulty can always be evaded by eliminating the vector potential from the equations, which is the preferable course to pursue.

In Chapter V., after discussing ordinary reflection and refraction, the author attempts to construct an electromagnetic theory of metallic reflection and refraction by taking into account the conductivity. This theory leads to Cauchy's formulæ, but requires that the real part of the pseudo-refractive index should be positive, whereas Eisenlohr has shown that for certain metals these formulæ cannot be reconciled with experiment unless the real part is negative. In the case of steel this quantity is positive throughout the whole range of the visible spectrum; but as thin films of iron, when magnetized, exhibit anomalous dispersion, it is doubtful whether this hypothesis is satisfactory even in the case of steel or iron.

The next four chapters are devoted to the principle of Huygens and to diffraction; and in Chapter X. the author has discussed Von Helmholtz's theory of anomalous dispersion. The advantage of theories of the class to which that of Von Helmholtz belongs is, that they endeavour to account for dispersion and absorption by taking into account the mutual reaction between ether and matter, and show that when one or more of the free periods of the vibrations of the matter coincides with one or more of the free periods of the rays of the spectrum, absorption and anomalous dispersion will be produced. By the aid of this theory the absorption produced by sodium vapour may be accounted for, as well as the anomalous dispersion and selective reflection produced by fuchsine and other aniline dyes. The author has not, however, developed the consequences of this theory as far as might be done.

It is not unnatural that M. Poincaré should have given special prominence to the writings of his own countrymen; his treatise would, however, have been much improved had he not confined himself so exclusively to the writings of French mathematicians, but had given a fuller account of the work done by mathematicians of other nationalities.

A. B. BASSET.

THE MOTHS OF INDIA.

The Fauna of British India, including Ceylon and Burma. Published under the authority of the Secretary of State for India in Council. Edited by W. F. Blanford. "Moths." Vol. i. By G. F. Hampson. (London: Taylor and Francis, 1892.)

MR. HAMPSON is already favourably known to entomologists by his work on the "Lepidoptera Heterocera of the Nilgiri District," which forms Part viii. of the series of "Illustrations of typical specimens of Lepidoptera Heterocera in the collection of the British Museum." In the work before us he has undertaken a far more important task; nothing less than a descriptive handbook of the moths of India, which, when complete, will prove as useful to Indian entomologists as the well-known work on the butterflies of India by Marshall and De Nicéville.

Hitherto the available information on the moths of India has been scattered over a great variety of books and periodicals, far too numerous and costly to be easily available out of London or Calcutta, and extremely difficult to use satisfactorily, even if accessible. But Mr. Hampson has been given the fullest facilities for examining all the principal public and private collections of Indian moths, from that of the British Museum downwards, and has also made free use of the libraries of the British Museum at South Kensington, which now contain the finest series of entomological books in the world; and the result is a work which can hardly fail to give an enormous impetus to the collection and study of Indian moths.

Much attention has been paid to the classification of moths, and the introductory pages are occupied with details of structure, illustrated by woodcuts of parts of the head, antennæ, legs, and neuration. This is followed by a genetic tree of the families of moths, and by a

tabular key based chiefly on neuration and antennæ. Mr. Hampson admits thirty-four families of Indian moths, of which the first twenty-three, including 1158 species, are dealt with in the volume before us. The earlier families of moths are, however, much less numerous in species than the later ones, and it must not be supposed that Mr. Hampson has dealt with anything like half the Indian species in his first volume, which comprises the series of families usually classed under Sphinges and Bombyces, extending, according to the author's classification, from *Saturniidæ* to *Hypsidæ*. The important Bombycide families, *Arctiidæ*, *Agaristidæ*, and *Uraniidæ*, are, however, relegated to the second volume, while several families of more or less doubtful position find a place in vol. i., such as the *Cymatophoridæ*, *Thyrididæ*, *Sesiidæ*, and *Tinægeriidæ*. We observe that Mr. Hampson closes the series of moths with the *Tineidæ*, *Pterophoridæ*, and *Alucitidæ*, and in this adopts the usual classification, though in the main he has struck out an entirely new classification of his own, and the very first innovation which meets the eye is the novelty of commencing the moths with the *Saturniidæ*.

We hope that Mr. Hampson will take an opportunity of discussing the various systems of classification of moths which have been proposed by Guenée, Herrich-Schäffer, Plötz, and other entomologists, not forgetting the strange system proposed by Zebrawski, in his work on the Lepidoptera of Cracow, in which the butterflies are placed in the middle instead of the beginning of the series of Lepidoptera. Such a discussion would be unsuitable in the present work, but if published elsewhere might be very useful.

Long descriptions of genera and species in a work of this character would have been out of place, and we are glad to find that they have been avoided. Each family or subfamily is succinctly characterised, and usually illustrated by a figure of the larva. This is followed by a tabular key to the genera, and then by a notice of the genera and species. The notice of each genus consists of synonymy, type, range, and a brief indication of the principal characters. That of the species includes synonymy, description, including both sexes, and transformations when necessary, range and expanse. An excellent woodcut is usually given of one representative of each genus, showing the wings and body on one side, and the neuration on the other, extra figures of antennæ and legs being sometimes added.

No book, however useful or carefully compiled, can be free from errors, but these cannot be detected at a glance, and the only technical mistake of importance which we have noticed in turning over Mr. Hampson's work is that the broad-bordered Australian *Macroglossum kingii*, Macl., is included among the synonyms of the narrow-bordered *Cephonodes hylas*, Linn.

Much, no doubt, remains to be said about Mr. Hampson's classification, his use of generic names, and his placing together insects regarded as distinct by other authors as synonyms. But these are all points admitting of great difference of opinion, and we do not propose to discuss them further in the present notice.

We should add that various new families, besides many new genera and species, are described by Mr. Hampson for the first time. W. F. K.

OUR BOOK SHELF.

The Year-Book of Science (for 1892). Edited by Prof. T. G. Bonney, D.Sc., LL.D., F.R.S. (London: Cassell and Co., 1893.)

ALL interested in scientific progress will welcome the appearance of the second volume of this useful year-book. The staff of contributors includes such names as Dr. Ramsay, Prof. Seeley, Mr. Botting Hemsley, &c., and the accuracy of the summaries of the year's developments may therefore be thoroughly relied upon. The plan of the volume follows closely on the lines of its predecessor, but it has been extended so as to include geographical and anthropological matters, and zoology has received more complete treatment. If one may judge of the activity in different departments of science by the space required for the account of their progress, electricity and organic chemistry would appear to take the lead. As in the last volume, no attempt has been made to present a complete catalogue of papers. The object has been simply to select the memoirs of exceptional interest; and so far as we have been able to judge, the selections have been judicious. An excellent index of subjects, and one of authors, complete what will no doubt be found a very useful volume.

Treatise on Thermodynamics. By Peter Alexander, M.A. Pp. xii, 203. (Longmans, Green, and Co., 1892.)

THIS is in many respects a singular work. Whole pages, we may almost say whole sheets, are devoted to the multiplication of elaborate proofs of intrinsically simple theorems for which a few lines would be ample allowance, while some of the real difficulties of the subject are but lightly touched on. The other special characteristics, so far as we have seen, are three in number. First, and most prominent, the extraordinary proportion of formulæ to text, which gives the whole the look of a treatise on Partial Differential Coefficients rather than on a branch of Physics. Second, the fearful and wonderful collection of names for special cycles, *e.g.* *Isothermentropicycle*, *Isobarymegacycle*, *Isenergentropicycle*, &c. Finally, the expressions of doubt or hesitancy with which many steps, universally recognised as valid, are introduced. In the first and second of these characteristics the author far transcends the results of the licence willingly allowed to pioneers like Clausius and Rankine. But these have been (at least in great part) long since discarded, and can never be reintroduced. The third characteristic is, to say the least, not precisely one to be desiderated in a text-book, where we naturally expect to find some slight trace of "Sir Oracle."

Mediæval Lore: an Epitome of the Science, Geography, Animal and Plant Folk-Lore and Myth of the Middle Ages. Being Classified Gleanings from the Encyclopædia of Bartholomew Anglicus on the Properties of Things. Edited by Robert Steele. (London: Elliot Stock, 1893.)

THE original work of which parts are translated in the present volume, may be said to have a place of its own in the history of European literature. It was written in the thirteenth century, and the Latin text was soon widely appreciated, while in the course of the fourteenth century it was translated into French, Spanish, Dutch, and English. The book is full of interest, for it presents a summary of all that was known in the Middle Ages about man and the world. The change which has been gradually effected by the use of modern scientific methods is, of course, incalculable; but some readers will probably be surprised to find to how large an extent Bartholomew mingles the results of shrewd and accurate observation with quaint fancies and unverified judgments. The present volume consists of selections from the edition of Berthelet, 1535; and the good style of the translator adds greatly to the charm of the author's

philosophy and science. Mr. Steele has done his work with much tact and care, and an interesting preface is contributed by Mr. William Morris.

Astronomy for Every-day Readers. By B. J. Hopkins, F.R.A.S. (London: George Philip and Son, 1893.)

THIS is a little book which aims at explaining in "as accurate and interesting a manner as possible such of the phenomena of the heavens as should be known to every intelligent person." It consists of six chapters dealing respectively with day and night, the phases of the moon, the tides, the seasons, eclipses, meteors, shooting stars, and comets. Descriptive astronomy is not touched upon, but there is an introductory chapter giving a general survey of the solar system and its dimensions. The book has been very carefully written, and the scientific explanations are much relieved by interesting references to the history of the subject. The author has succeeded in giving very clear and concise accounts of the every-day phenomena with which the book specially deals, and it seems well adapted to awaken a desire for more in the class of readers to whom he more particularly appeals. A biography of the author—who is described as "the working-man scientist"—is also included.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Blind Animals in Caves.

IN an article in the current number of the *Contemporary Review* Mr. Herbert Spencer discusses the "familiar instance" of blind animals in caves as bearing upon the hypothesis of the transmission of acquired characters. Mr. Spencer is not satisfied with the explanation of the blindness of these cave animals offered by Weismann, who endeavours to account for them by two conditions recognised as operating in regard to other cases by Darwin, viz. cessation of selection and parsimony of growth ("Origin of Species," sixth edition, p. 118), of which the former author has treated under the name Panmyxia. Mr. Spencer shows that the saving of ponderable material in the suppression of an eye is but a small economy: he loses sight of the fact, however, that possibly, or even probably, the saving to the organism in the reduction of an eye to a rudimentary state is not to be measured by mere bulk, but by the non-expenditure of special materials and special activities which are concerned in the production of an organ so peculiar and elaborate as is the vertebrate eye.

That, however, to which I wish here to draw the attention of Mr. Spencer and his readers is this:—Mr. Spencer appears to think that if he disposes of Weismann's explanation of the blindness of cave-animals according to "Panmyxia"—there remains only the explanation by "transmission of acquired characters" in the field. He appears not to be acquainted with the explanation which I have offered of the blindness of cave-animals. It is closely similar to that given by Darwin of the occurrence of wingless insects on oceanic islands. My explanation consists in an application to the case in hand of Darwin's principle of "natural selection." I published it some years ago in my article "Zoology" in the "Encycl. Britannica," reprinted in 1890 in a volume of essays, bearing the title "The Advancement of Science." My suggestion was (and is) as follows, and I should like to see what Mr. Spencer has to say to it:—"This instance (that of the blind cave-animals) can," I wrote in the article above-named, "be fully explained by natural selection acting on congenital fortuitous variations. Many animals are thus born with distorted or defective eyes whose parents have not had their eyes submitted to any peculiar conditions. Supposing a number of some species of Arthropod or Fish to be swept into a cavern or to be carried from less to greater depths in the sea, those individuals with perfect eyes would follow the glimmer of light and eventually escape to the outer air or the shallower depths, leaving behind those with imperfect eyes to breed in the dark place. A natural selection would thus be effected. In every succeeding generation (bred in the dark place) this would be the case, and even those with weak but still seeing eyes would in the course of time escape, until only a pure race of eyeless or blind animals would be left in the cavern or deep sea."

My own position in regard to the hypothesis of the transmission of acquired characters remains what it was ten years ago, viz. that in the absence of observed instances of this transmission and in the presence of repeated observation that particular acquired characters are *not* transmitted, I do not consider it legitimate to *assume* a transmission of acquired characters as the explanation of any given case, such, for instance, as that of the blind cave-animals. I am confirmed in this attitude by the fact that a little consideration has enabled me and others to explain satisfactorily, by reference to no hypothetical causes, but to the admitted and demonstrable facts of "congenital variation" and "natural selection," instances brought forward as "only to be explained on the assumption of the truth of Lamarck's hypothesis."

On the other hand, I have always considered that there is not sufficient ground for asserting that a transmission of acquired characters *can not* take place. The important question is still as it was five years ago, "*Does* it take place?"

Oxford, February 14. E. RAY LANKESTER.

Glacier Action.

I HAVE read with great interest and pleasure the short review in your paper of last week by Prof. Bonney, giving a summary of the results of a survey of the French freshwater lakes, and indicating as the most probable conclusion that they cannot be accounted for on the theory of the late Sir A. Ramsay, by the digging-out power of glaciers.

Living as I do in a highly glaciated country, and in a country also full of lakes, both fresh and salt, I have never believed in that theory. Lakes seem to me to be due to the same causes which have produced the glens and hollows in which they lie, and these causes cannot be identified with glacier action alone. The theory of Ramsay attributes to glacier action powers and effects which have never been proved to belong to them. Glaciers do not dig out. They rub down—abrade—and scoop, when they are moving down inclined planes at angles more or less steep. But when they reach level ground they do not dig; they rest upon the level surfaces, and when pressed from behind they flow over it. But I have never seen any proof that they can act like a ploughshare, or rather like one of the new digging machines.

In so far as all existing glens may have been formerly occupied by glaciers, their depths must have been increased by glacier action, on the supposition that they were tilted, or upraised at some angle required for this form of true glacier action. On this supposition, indeed, lake basins may be said to be partly due to glaciers. But then this supposition involves and depends upon the assumption that earth movements have made the lake basins what they now are—hollows in a comparative level.

Like all other general theories in the history of geology, the "glacial theory" seems to me to have been ridden to the death, and I have been long waiting for some signs of that reaction or correction which is still much needed. I hold that in this country there is not only no evidence of "ice sheets" overriding all the hills, but the strongest evidence against such sheets. Our glens had true glaciers in abundance, no doubt, and they have left their tool-marks very distinctly. But those marks are quite inconsistent with one universal ice-cap or ice-sheet over all the land. ARGYLL.

Inveraray, February 16.

Dr. Joule's Thermometers.

EVERY one will, I am sure, be glad to know that Dr. Joule's thermometers are under investigation by Prof. Schuster.

It is unfortunate that Joule does not give the actual readings of the freezing point, but if the comparison quoted by Rowland was made in either 1879 or 1890 it may be that he referred to the reading of November, 1879, when the total rise of the zero point was 12·92 scale divisions. In that case the original reading in April, 1844, would be 9·70; at any rate this number cannot be very far from the truth.

The temporary changes of zero point alluded to by Prof. Schuster certainly complicate the matter, but from the numbers given it would appear that since 1879 or 1880 there has been a

further secular rise of from 0·38 to 0·89 of a scale division. Nothing is said in Joule's paper about the temperatures at which the thermometers had been kept before the readings of the freezing point were taken, but as the later observations—and most of the earlier ones—were made in the winter months, it may perhaps be assumed that the temperatures were nearer 7° than 30°, and that the actual reading on the scale last winter should be taken as nearer 23·51 than 23·00. If this is so the total rise of the zero point last winter would be nearer 13·81 than 13·30.

Prof. Schuster states that "with properly annealed thermometers the secular changes are much smaller than the temporary ones," and that is no doubt true for observations extending over a limited time and with such comparatively large variations of temperature as from 7° to 30°. It may be pointed out, however, that the secular rise since 1879 or 1880 is probably greater than the maximum temporary change recorded by Prof. Schuster, and of course the total secular rise is enormously greater.

It may be true that the secular changes of a thermometer gradually vanish, but it must, I think, be conceded, that in the case of Dr. Joule's thermometer it will be a long time before absolute constancy is attained. There can be no doubt that even now, nearly forty-nine years after the first reading was taken, the zero point is still rising, and it does not appear to me to be very improbable that during the next fifty years there may be a further rise of two scale divisions, the amount calculated from the purely empirical formula which I have suggested.

SYDNEY YOUNG.

University College, Bristol, February 20.

Foraminifer or Sponge?

UNDER the above heading in last week's NATURE Dr. Hanitsch briefly draws our attention to Mr. A. Goës' report on the deep sea organisms procured by Prof. Agassiz in the American tropical Pacific, which he describes as Arenaceous Foraminifera, with the name *Neusina Agassizi*.

As it was from me that Dr. Hanitsch received the specimens he describes, which I had after a personal conversation on the matter sent him, for his opinion as to their relation to true sponges, I venture to send some further observations on these interesting forms.

Dr. Hanitsch is, I believe, quite right in referring Mr. Goës' Neusina to Prof. Haeckel's *Stannophyllum zonarium*, as described in his report on the *Challenger* deep-sea Keratosa. But while admitting my admiration of Prof. Haeckel's wonderful production on the *Challenger* specimens, I do not agree with him as to their being true Keratose sponges.

My conclusion is based upon the examination of nearly the whole *Challenger* collection, and in not one species could I find the slightest trace of any of the flagellated chambers characteristic of sponges.

Prof. Haeckel accounts for the absence of this important feature through the bad preservation of the specimens. Yet he describes the most delicate parts of a commensal Hydroid in full, and was able to observe amœboidal cells, and the granulated sarcode bodies peculiar to all bottom living Foraminifera.

If, however, the forms described by Prof. Haeckel prove after all to be true Keratose sponges, the present state of our knowledge does not justify their separation from such recognised genera of Foraminifera, as Masonella, and Syringammina of the late Dr. G. Brady; Technitella, Haliphysema, and Marsipella of Canon Norman; or *Hyperammina palmiformis*, described by myself from the Faröe Channel, all which forms have the power of forming siliceous and chitinous skeletons.

Without going into further detail here it will be readily understood that I quite agree with Mr. Goës in placing these organisms among the Foraminifera, although it would have been better had he given us a clearer and more detailed description of his Neusina.

I had hoped to have published my personal observations on these most interesting organisms, but circumstances have prevented me doing so up to the present.

I for one would be glad if Dr. Hanitsch would give his opinion as to their supposed sponge structure, which he has not done in his previous letter.

F. G. PEARCEY,
Late of the *Challenger* Expedition and Commission.

Owens College Museum, Manchester.

Colonial Meteorology.

ON p. 363 of your last number your reviewer of the "Year-book of the Imperial Institute," after remarking that "climate certainly deserves better treatment," continues:—

"We do not think space would be wasted in giving the mean monthly temperatures and rainfall for the average year and for two extreme years, at a few representative stations in the larger colonies. This information cannot indeed be found in any existing books, but must be worked out from original records, which exist abundantly, and are rarely made available to practical workers."

I am afraid that the reviewer does not always read NATURE, for you, sir, have on several occasions noticed my efforts in this direction, efforts which have gone on uninterruptedly for twenty years. As, now that you have taken the matter up, it is not improbable that some of the funds lavished on the Imperial Institute may be devoted to the subject, and my small organisation be swamped or superseded, I hope that you will, in justice to the directors of the various Colonial observatories who have helped me for so many years, and as some consolation for the entire ignorement of our organisation by your reviewer, allow me to give its history in the fewest words possible.

In 1873 I determined to try to publish monthly a table giving the principal climatic data for each synchronous month at widely spread stations over the entire British Empire. The leading idea was identity, so as to ensure comparability. I therefore prepared some blank forms and sent them with a circular letter to about twenty of our leading Colonial meteorologists. Every one without exception promised to help, and it says much for colonial climate to add that during the subsequent twenty years not more than five or six of my original correspondents have passed away.

During the period occupied in the transit of my request and of the replies thereto, I wrote a series of short articles pointing out the leading features, and as far as practicable the mean values, for the various stations, so that when we began publishing the monthly values, the departures from the mean could be recognised. These articles and the tables themselves from 1874 to 1881 appeared in *The Colonies* (subsequently *The Colonies and India*). When in 1882 that paper passed into other hands, the proprietors declined to publish the tables, and I began to insert them in the *Meteorological Magazine*, where they have appeared regularly month by month for the subsequent thirteen years. At the close of each year an extra table is given with a summary of the results for the year, and NATURE has often done me the honour of quoting portions of these summaries.

I enclose copy of our last table, and though I know that to reproduce it would be to make a somewhat large demand upon your space, I feel that the work (wholly unpaid, be it remembered) of my Colonial friends during these past twenty years, claims some consideration and some recognition. You will see by the signatures that the authorities are the highest attainable.

G. J. SYMONS.

62, Camden Square, N.W., February 17.

Ozone.

WITH reference to a paragraph in NATURE, p. 373, on observations of ozone in the atmosphere, and the paucity of observers and records, I may be allowed to state that I have collected sets in the North Atlantic and Pacific Oceans and Mediterranean. These have been taken by officers of the Royal Navy and mercantile marine at sea, and some of the records have been tabulated, and may be communicated to some society in due course. Moffatt's papers, made by Negretti and Zambra, have been used throughout, so the observations are all uniform and comparable.

W. G. BLACK.

Edinburgh, February 19.

LION-TIGER AND TIGER-LION HYBRIDS.

THE Council of the Royal Zoological Society of Ireland entertain some hope that it will be possible to produce in their Gardens examples of hybrids or cross-breeds between the two largest species of cat, namely, the lion and tiger.

That such hybrids have been produced is a matter of historical record, and as the writer is particularly inter-

ested in the success of the experiment now in progress in the Dublin Gardens, where over one hundred lion cubs have been successfully reared, he thinks it desirable to record all the details which he has been able to collect on the subject.

So far as can be ascertained the only lion-tiger cubs, as they have been called, which were ever produced belonged to several distinct litters by different parents, perhaps, but in the same menagerie—that of F. Atkins, of Windsor.

The father of the first litter of these cubs was a lion bred in Atkins's menagerie, the head-quarters of which were at Windsor. The mother was an imported tigress. From Griffith's account ("Animal Kingdom," vol. ii. p. 448, 1827) it would seem that the lion and tigress were about two years together, in the same cage, before any issue appeared. The first litter, consisting of three cubs, was born at Windsor on October 17, 1824—being the result of a particular intercourse which lasted for ten or twelve days in the beginning of the previous July. The cubs were shortly afterwards exhibited to his Majesty, who, according to the showman's own handbill—a copy of which has been lent to me by Dr. William Frazer—christened them lion-tigers. The lion died six weeks afterwards, and the cubs, as related by Griffith, were fostered by several bitches and a goat, and it was expected would attain to maturity; but although there is no clear intimation as to the exact date when this was written, the figures of the cubs accompanying the account are said to represent them at the age of only about three months. It is stated by one writer, however, that they did not attain to maturity ("English Cyclopædia Nat. Hist.," vol. ii. p. 763, art. "Felidæ," 1854).

The next litter was born at Edinburgh on December 31, 1827, according to Atkins's showbill and Sir William Jardine's works.[1] There were two cubs, and it would seem that they were exhibited together with, and therefore probably reared by, the mother, in the same den; but whether she were the same tigress as the mother of the previous litter is not clear.

They were seen by Sir William Jardine in September, 1828, and his figures may have been taken from them; but it has some resemblance in details, though not in general pose, to the figures published by Griffith of the 1824 litter. It would seem that Sir William was under the impression that it was these very cubs which were subsequently exhibited together with their parents in the same cage in the autumn of 1829. But there is a difficulty in accepting this conclusion, because the stuffed specimens of these two cubs still exist—one in the British Museum (Natural History) and the other in the Science and Art Museum, Edinburgh. I have recently had opportunities of examining both, and I should be inclined to think that the cubs were not *more* than about nine or ten months old when they died. So that either the cubs seen in 1829 were born subsequently to December 31, 1827, or the stuffed cubs just referred to must have been born previous to that date. That the cub in the British Museum was presented by J. Atkins, of Windsor, is attested by Dr. Gray's "Old List," page 40, which, through the courtesy of Dr. Günther, I have been able to consult.

That the specimen in Edinburgh was one of those born in 1827, and figured by Sir William Jardine, is, indeed, stated in the "English Cyclopædia," which adds that the cubs of that litter died young. Hence, it seems most probable that the cubs seen in the autumn of 1829 belonged to a subsequent litter, as has been suggested above. Further, Mr. J. G. Robertson, formerly of Kilkenny, has informed me that he saw a lion, tigress, and their three hybrid cubs in one cage in Kilkenny, where they were brought by a showman about the year 1832. They were the sole stock of the show.

[1] "The Menageries, Quadrupeds," Sir William Jardine (2nd edition), vol. i. pp. 191, 192. 1830.

Accordingly, it seems that besides the definitely attested births of the years 1824 and 1827, there were also, probably, some others. One of the accounts states that there is no great difficulty in promoting the union of the two species.

Besides the cub already referred to as having been presented to the British Museum by J. Atkins, I have also been shown by Dr. Günther unmounted skins of two reputed hybrid lion-tiger cubs, which are said in Dr. Gray's list to have been purchased from a dealer named Mathur, in 1842. They cannot, I think, have survived more than two or three days after birth, and their markings are too indistinct to justify any special description, particularly as their parentage is not more definitely attested. But it is of some importance to place on record here what is said as to the markings of the cubs first referred to. The specimens in the British and the Edinburgh Museums are both somewhat faded. In Gray's list the former is thus described: "Hybrid cub between lion and tigress; yellow; back slightly waved; limbs and tail banded with black."

Sir William Jardine merely says the general colour was not so bright as that of the tiger, and the transverse bands were more obscure.

Griffith describes the cubs he figured as follows:—

"Our mules, in common with ordinary lions, were born without any traces of a mane, or of a tuft at the end of the tail. Their fur in general was rather woolly; the external ear was pendant towards the extremity; the nails were constantly out, and not cased in the sheath, and in these particulars they agreed with the common cubs of lions. Their colour was dirty yellow or blanket colour: but from the nose over the head, along the back and upper side of the tail the colour was much darker, and on these parts the transverse stripes were stronger, and the forehead was covered with obscure spots, slighter indications of which also appeared on other parts of the body. The shape of the head, as appears by the figures, is assimilated to that of the father's (the lion); the superfineness of the body on the other hand is like that of the tigress" (p. 449).

Prof. R. H. Traquair, F.R.S., keeper of the natural history division of the Edinburgh Museum, has kindly had a photograph taken of the specimen above referred to prepared for me, and the transverse markings are distinctly visible in this picture.

I am tempted to conclude this record with an extract from Atkins's somewhat quaintly-expressed handbill, which does not bear any date, but probably belonged to the year 1828. The greater part of the bill consists of a long poetical description of the family with "a tigress their dam, and a lion their sire," and of the numerous distinguished persons who had paid them a visit. The following prose portion will probably be sufficient to extract from what is possibly one of few still existing copies of the handbill.

"ATKIN'S IMMENSE MENAGERIE.

"Wonderful Phenomenon in Nature.

"*The singular, and hitherto deemed impossible, occurrence of Lion and Tigress in one den.*

"Cohabiting and producing young, again took place in this menagerie, on the 31st of December, 1827, at the City of Edinburgh, when the royal tigress brought forth two fine cubs!! And they are now to be seen in the same den with their sire and dam. The first litter of these extraordinary animals were presented to our most gracious Sovereign, when he was pleased to express considerable gratification, and to call them lion-tigers, than which a more appropriate name could not have been given. The great interest the lion and tigress have excited is unprecedented; they are a source of irresistible attraction, especially as it is the only instance of the kind

ever known of animals so directly opposite in their dispositions forming an attachment of such singular nature. Their beautiful and interesting progeny are most admirable productions of nature. The group is truly pleasing and astonishing, and must be witnessed to form an adequate idea of them. The remarkable instances of subdued temper and association of animals to permit the keeper to enter their den, and to introduce their performance to the spectators, is the greatest phenomenon in natural history."

V. Ball.

OBSERVATIONS OF ATMOSPHERIC ELECTRICITY IN AMERICA.[1]

The meteorological official of the United States known as "The Chief Signal Officer" has sanctioned the publication of this voluminous report of 320 quarto pages, embodying the result of a widespread photographic record and direct reading of atmospheric electrometers carried out under the auspices of the United States Government during the years 1884 to 1888, with the immediately utilitarian object of ascertaining how far it was possible to use electrical indication in weather prediction. As Mr. Mendenhall says, "No studies or investigations which did not bear upon this question were [considered] proper or allowable."

Although thus limited in scope the actual observations made and here recorded can hardly fail to be of service to future investigators into this obscure subject.

The report begins with a historical introduction, in which it is admitted that electricity was first purposely drawn from the clouds in France by Buffon and D'Alibard about a month before Franklin tried his already projected experiment; and that de Saussure was one of the first to obtain fairly quantitative results and to detect a diurnal period.

Volta "hit upon the capital device of a burning match" to replace the previous feeble collecting devices such as a bullet and wire shot up into the air. But nothing really exact and continuous was done "until Sir W. Thomson attacked the problem." He introduced the quadrant electrometer and the water-dropper, which have been the universal recording instruments ever since.

In fact "the work of Palmieri on Mount Vesuvius constitutes perhaps the only extensive series of observations in which instruments founded on the original design of Sir W. Thomson have not been used."

In the States the first energetic and influential mover in the direction of a serious record appears to have been Prof. Cleveland Abbé, who got himself authorised in 1880 by the Chief Signal officer to consult with Prof. Rowland on the subject, and afterwards with Prof. Trowbridge, and to make arrangements for a series of effective observations. Under the auspices of these gentlemen a staff of observers were trained and suitable instruments obtained, tested, and improved. Various collectors were tested, and in 1883 a photographic registration apparatus of M. Mascart was put into operation. In 1884 Mr. Mendenhall "was appointed to assume the direction of the work as chief of the physical laboratory and instrument division of the office in Washington." Stations were established in Washington, Baltimore, Boston, New Haven, Ithaca, and Ohio.

Much work was done in connection with electrometers by McAdie and McRae, but this is incorporated in the article "Electrometer" of the "Ency. Britt."

The instrument ultimately adopted was a quadrant electrometer of the Mascart pattern with special improvements, and was constructed by the Société Génevoise. A picture of it is given.

The method of connecting the quadrants to the two equal halves of a water battery, so that they might always be at equal opposite potentials, and of attaching the needle to the collector, was after many trials adopted; partly because higher insulation was thus possible, partly in order to get a straight line law. Deviation from this, due to what is called the "electric directing couple," is not overlooked, but by a stiff suspension and small range it is minimised.

An interesting chapter is that on "collectors." The water-dropper was mostly used, but its freezing is apt to interrupt the record. "Sergeant Morrill experimented on a special flame collector," supplied with gas at constant pressure and arranged so that wind could not extinguish it, and "before the termination of the work obtained very satisfactory results." But in order to secure uniformity between different stations he also designed a mechanical collector—a clockwork machine with revolving arm and intermittent contacts, which is virtually a gigantic replenisher, utilising the atmospheric potential as an inductor, and thereby feeding the electrometer up to the same potential. It seems to be as quick in response as a water-dropper (an important point, as some of the fluctuations of potential are very rapid), but "as it was only completed towards the end of the period of observation nothing very definite can be said of its performance." An illustration of the ingenious device is given in detail.

Observations.

Preliminary records are given showing the curves got at a roof station and a balcony station, also at different observatories in the same town. Some also from the top of the Washington Monument, which naturally show far greater potential and changes than the instrument in the Signal Office.

There are plotted a number of zigzags obtained from the different stations about the States, and very complicated and entangled the record is. None of the stations show any agreement; and, particularly at Ithaca, the electrometers seem usually to have been in a wildly excited state.

But during an Aurora on May 20, 1888, they were singularly quiet, and the remark is made: "It will be observed that the indications of the electrometer were positive during the day and night, and that no unusual fluctuations occurred."

The atmospheric potential is usually positive, and it has been often thought that a change to negative signalised bad weather. Certainly this does frequently happen; sufficiently often to make it worth while specially to examine this point; and several curve charts are given to show that "negative electricity in clear weather was observed at most if not all of the Signal Service Stations on numerous occasions during the progress of the work. In many cases precipitation occurred at points 10 to 100 miles distant, but in others clear weather prevailed over almost the entire country. A number of instances of negative potential during clear weather occurred at Ithaca, where careful attention was given to the matter of special observation by Mr. Schultze."

Effect of Dust, Haze, Fog.

"The effect of dust, haze, smoke, &c., in producing negative potential has been noticed by more than one observer. [Query whether the negative potential can have ever produced or permitted the haze.—O. J. L.] Several instances of the action of clouds of dust were noted by Sergeant Morrill at Boston. On March 7, 1888, in the afternoon the potential was observed to fall rapidly from -90 to -270 upon the rising of an especially heavy cloud of dust, and similar phenomena were observed on April 7." "A fall of potential could be certainly predicted when a dust cloud was seen rising. On other days when high winds and dust clouds prevailed negative potential

[1] "Report of Studies of Atmospheric Electricity." By T. C. Mendenhall. Extract from Memoirs of the National Academy of Sciences, 1889. (Washington.)

was observed. A figure is given of an observation at Terre Haute, Ind., on a day when a fog formed after sunset, and the potential then rapidly fell from + 1000 to − 200 volts." "The same phenomenon was frequently observed during the autumn when the formation of a haze or fog just as the sun was setting was a common occurrence."

The observer at Terre Haute (Sergeant McRae) wisely made special observations as to the possible effect of locomotives on a railway a quarter of a mile distant; but, so far as the recods show, the passage of a train, when not happening to coincide with a fog formation, did not seem to disturb the curves.

Clouds and Wind.

"The direct action of a cloud or group of clouds in producing a fall of potential was often observed." For instance the following at Boston:—"In the morning of January 3, 1888, the potential had been steadily positive. At 11.30 it was + 32 volts, from which it fell steadily at the approach toward the zenith of a small cumulus cloud, reaching − 21 volts As the cloud passed away the potential rose to + 6, again falling to − 31 as a large mass of cumulus clouds approached. Later the sky became overcast, and the potential became steadily negative.

"On June 7, at 5.30 p.m., the potential fell from + 43 to − 173, and then rose slowly to its former value. The rise and fall occupied fifteen minutes, and coincided with the appearance over the buildings to the west of a fleecy cirro-stratus cloud and its disappearance over the institute building in which the electrometer was located.

"Again, on June 9 the potential was positive all day up to 5 p.m. At that hour it fell from + 73 to − 113, then rising to + 52. The sky was nearly free from clouds, and the fluctuation coincided with the approach and departure of a cirro-stratus cloud, passing about 15° from the zenith. The inductive action of the cloud was plainly suggested in all of these cases."

High wind also usually causes a drop of potential.

Averages.

Some charts are then given of average monthly potentials, showing nearly always positive average values, highest in the winter, lowest in summer.

Some smoothed diurnal curves are also given, and "seem to indicate the existence of two principal maxima of potential in the day, and also in a general way that one of these occurs not many hours before noon and the other toward the latter part of the day."

Thunderstorms.

Special attention was paid to the observations before, during, and after the occurrence of thunderstorms, but the needle then dashes wildly to either side, and sparks often begin to pass. And the remark is made:—"Aside from the general characteristics (rapidity and range of fluctuation) these potential curves seem to have little in common. The examination of a few cases only might lead to interesting conclusions, which would almost certainly be overthrown by the study of a greater number. Sometimes the potential falls rather steadily until the violent movements begin, but sometimes it rises just as long and steadily. In many cases the fluctuations start from a high positive, while in many others the reverse is the case. The storm is usually accompanied by precipitation; sometimes this begins before the needle starts on its series of swings from side to side, and sometimes these movements precede precipitation. The steady rise of potential for some hours immediately following a thunderstorm may mean that clear and fair weather is to be expected, but Fig. 71 is good evidence that it may also be interpreted to mean that another thunderstorm is just at hand."

"Although these records are somewhat unsatisfactory as far as throwing any light upon the nature of thunderstorms, it must not be forgotten that with a single exception [two stations at Washington] none of these storms have influenced more than one station. The complete investigation of a storm would demand a large number of observing stations relatively near to each other, by means of which a full history of the potential changes about and in all parts of the storm could be obtained.

"Such an examination might result in bringing order and system out of what seems at present little less than confusion."

Then follow many specimens of the actual photographic record at Baltimore on days when lightning occurred, and finally a mass of tables embodying abstracts of results at the different stations, and also some taken at Kew and Greenwich in England; though at both of these institutions the scale used appears to be arbitrary.

General Conclusions.

Among the conclusions the following may be noted: "Instruments similar in every respect, separated by a distance of a hundred meters may give very dissimilar indications." (Not merely, it is explained, as regards *absolute* values only, which may be expected to disagree, but as regards fluctuations also.) "Observers were instructed to study the appearance of negative electricity before and after and during precipitations, and at one time the hope was indulged in by the writer, as well as by several of the observers, that this phenomenon might afford great assistance in the prediction of local storms, rains, snows, &c., which offer so much difficulty in forecasting by present methods.

"Further observation and investigation, however, did not justify this expectation, serving rather to increase the meteorological conditions under which negative potential might be looked for, and to diminish the definition of relationship between it and precipitation. That negative electricity is tolerably certain to be observed in connection with precipitation in a majority of cases is doubtless true, but it does not appear in such a way as to be of any value in forecasting."

Near the end of the historical introduction we learn with regret that the observations thus tabulated and discussed are now no longer going on.

"In August, 1888, all observations were discontinued. It was thought that a sufficient number had been accumulated to decide the question of their use in weather forecasting, and in fact their study up to that date gave little encouragement in that direction." "Many questions of great scientific interest . . . had to be set aside for those likely to be of immediate practical value."

The amount of material thus rapidly accumulated, centralised, and well discussed, is typical of what can be done under efficient Government authorisation and by the head of a National Laboratory. The carrying on of the research for immediate utilitarian ends, and stopping it as soon as it was seen that the results aimed at were not forthcoming, is perhaps also typical.

It is to be hoped that some day the question will be reopened, and a fresh series of results obtained. So far as I (who am by no means a meteorologist) can judge, I should surmise that a number of fairly concentrated stations over a large plain would be desirable; and also that the vertical gradient of potential should be attempted by a series of collectors at different attitudes on a tall mast, or possibly up a hill-side.

Further, the general aspect of the curves seems to me to suggest that the instruments were almost too sensitive and not sufficiently dead-beat. They should be quick in indication and at the same time thoroughly damped, so that the record shall contain as little as possible of any effect due to instrumental inertia. Some very light

quartz-fibre instrument might be devised, and perhaps it might contain its own recording apparatus in a compact form, so as to make registration a much easier and less cumbrous business than it has been hitherto.

When so much is unknown it is a mistake to begin by observing with too great intricacy of detail. The salient features should be first obtained, and then attention directed to the minutiæ; but one of the first things to do is to arrange that every swing in the curve shall mean a swing of atmospheric potential, and not a mere excursion of a heavy needle.

I hope that the energy, skill, and judgment of the various observers in the States, and of Mr. Mendenhall, the author of this valuable report, may be utilised through the resources of the U.S. Government by the inauguration of a fresh series of observations under somewhat different conditions, and without the hamper of any immediately specified practical object. OLIVER J. LODGE.

THE PRESERVATION OF THE NATIVE BIRDS OF NEW ZEALAND.

IN our issue of September 16 last year (vol. xlvi. p. 502) we printed an excellent memorandum drawn up by Lord Onslow, late Governor of New Zealand, relating to a proposal for the preservation of the native birds of that colony by setting apart two islands for this purpose, namely, Little Barrier or Hauturn Island in the north, and Resolution Island in the south. As regards the first of these islands, we have lately received a copy of the report by Mr. Henry Wright (addressed to the Hon. John Ballance, Premier of New Zealand) upon the subject. According to Mr. Wright, Hauturn Island, in the Gulf of Hauraki, which is almost circular in shape, and contains an area of from 9000 to 10,000 acres, rising in the middle to an elevation of about 2000 feet, is very well adapted for the purpose required. Writing with a thorough knowledge of all the north island, Mr. Wright is able to say that there is no other part of it where the native birds are to be found in anything like such profusion and variety. He gives a list of forty species to be met with within its limits, and mentions as particular varieties the stitch-bird or kotihe (*Pogonornis cincta*) and the large dark kiwi (*Apteryx bulleri*) as both found there. There are slight difficulties in the way of the project, such as the presence of about a dozen Maoris now living on the island, and of a claimant for the timber, which, in the shape of kauri pine (*Dammara australis*), is present in large quantities. There are no Weka Rails (*Ocydromus*) in the island to destroy the birds' eggs; and there are no bees, which, for some reasons, are considered to be highly inimical to the native birds in New Zealand. The wild pigs, formerly numerous, have been killed out; and the mutton-bird (*Œstrelata gouldi*), the young of which were formerly eaten by the pigs, will consequently be able to breed again undisturbed. Cats unfortunately are very numerous, but Mr. Wright proposes to offer at once a reward for their destruction, which is, of course, of great importance.

Mr. Wright's report seems quite convincing as to the suitability of Hauturn Island for the object in view, but we regret to hear that some difficulties have arisen in the Parliament of New Zealand as to the appropriation of the funds required for the purpose.

Lord Onslow, however, is not disposed to let the matter drop, and will, we are sure, be strongly supported by Lord Glasgow, the present Governor of New Zealand, in carrying the matter to a successful issue. The Council of the Zoological Society of London, whose attention has been called to the subject, have passed in its favour the following resolutions, which were communicated to a general meeting of that body on the 16th inst.

(1) The council of the Society have learnt with great satisfaction the steps that were proposed to be taken by the Earl of Onslow, when Governor of New Zealand, and by the Houses of General Assembly for the preservation of the native birds of New Zealand, by reserving certain small islands suitable for the purpose, and by affording the birds special protection on these islands.

(2) The council much regret to hear that difficulties have been encountered in carrying out this plan as regards one of these islands (Little Barrier Island), and trust that the Government of New Zealand may be induced to take the necessary steps to overcome these difficulties and to carry out this excellent scheme in its entirety.

(3) The council venture to suggest that besides the native birds to be protected in these reserves shelter should also be afforded to the remarkable Saurian, the Tuatera Lizard (*Sphenodon punctatus*), which is at present restricted to some small islands on the north coast of New Zealand, in the Bay of Plenty.

These resolutions have been communicated to the present Governor of New Zealand, and will, we trust, be of some assistance to him in inducing his Ministers to carry this excellent scheme into execution.

THE EARTHQUAKES IN ZANTE.

THE following is a list of the shocks of earthquake at Zante, compiled from telegrams published in the *Times* and *Standard*:—January 31, at daybreak, the most destructive earthquake, of which, however, some warning must have been given, if we may judge from the comparatively small loss of life. Other slighter shocks followed during the day. February 1, 2 a.m., another severe shock, felt also in Cephalonia. February 2, two more violent shocks, one of which caused some fresh damage. February 3, further shocks, but less frequent and violent. February 5, another violent shock. February 6, continued shocks of slight intensity, followed by three more severe ones in the afternoon and evening. February 7, another violent shock in the morning, resulting in but little additional damage. February 8, some slight shocks. February 10, some slight shocks in different districts. February 11, 1 a.m., a somewhat severe shock, followed by a succession of shocks between 8 and 9 p.m. February 12, further shocks in the early morning, soon after midnight, and again at intervals during the day. February 13 or 14, renewed slight shocks, accompanied by loud subterranean rumblings. The Athens correspondent of the *Times*, telegraphing on February 20, says: "The shocks of earthquake continue at Zante, with varying degrees of violence. No serious damage is reported, but those who are compelled to live in the half-ruined or insecure houses are exposed to frequent alarms." It is estimated that the total loss of property due to the shocks may exceed £600,000.

According to a telegram in the *Times* for February 6, the tide in Venice on the evening of February 1 "ebbed so low as to leave several of the canals without water. The gondola traffic was interrupted at different points, and many of those craft were stranded. This phenomenon corresponded with the earthquakes at Zante and Cephalonia." A simple calculation will show, however, that this can hardly have been due to the principal shock. The straight line joining Zante and Venice passes almost directly up the Adriatic, and its length is roughly 720 miles. Taking the time between daybreak on January 31 and the evening of Feb. 1 at 36 hours, this would give for the sea-wave an average velocity of 20 miles an hour, corresponding to an average depth of about 30 feet, which is considerably less than the actual amount, the mean depth of the Adriatic being 110 fathoms.

Earthquakes are frequent in Zante, and sometimes very severe. One of the most destructive shocks, which occurred on October 30, 1840, is described by Ansted in

his work on the Ionian Islands (pp. 415-419) chiefly from the report of the Lord High Commissioner, Sir Howard Douglas. The prison was in this case also unroofed, and hardly a house in the town of Zante escaped some injury. All of the villages on, or bordering on, the plain suffered more or less, especially Sculikado, which was reduced to a heap of ruins. The total amount of damage done was estimated at not less than £300,000. The great earthquake was followed by a large number of others, some very severe, ninety-five being counted up to November 4. Ansted notes (pp. 368, 369) the curious fact that each of the Ionian Islands seems for the most part to have its own earthquakes, independently of the others. About the year 1818, he says, all the sensible shocks in Cephalonia and Zante were tabulated, the record extending over two and a quarter years. "During this time thirty distinct and well-marked shocks were recorded in Cephalonia; but in no case did the shocks in Zante, although nearly contemporaneous, absolutely coincide with them. In most cases an interval of some days, and almost always more than twenty-four hours, seems to have elapsed between the times of the disturbances in the two, although they are so near that in these days [1863] of long range, a cannon-shot fired from the one might reach to the other."

NOTES.

THE French Academy of Sciences has opened a subscription in support of the movement for the publication of the writings of Jean Servais Stas and the erection of a monument in his memory.

A MEETING of delegates of the Academies of Science at Berlin, Göttingen, Leipzig, Munich, and Vienna was held on January 29, under the presidency of Prof. Ribbeck. The object of the meeting was to prepare the way for a sort of federal union of the various German scientific societies, so that they may be able to act together about important matters of common interest. A hope was expressed that a great international confederation of scientific societies might ultimately be formed.

ANNOUNCEMENT has been made of the death, on February 2, 1893, at Hendaye, in the Department of the Basses Pyrénées, in his sixty-eighth year, of M. Victor Aimé Léon Olphe-Galliard, author, among other works, of "Contributions à la Faune Ornithologique de l'Europe Occidentale," in forty livraisons (of which the last was published in 1892) giving an elaborate description of the birds not merely of Western but of almost the whole of Europe, to say nothing of allied species belonging to other countries. M. Olphe-Galliard (whose name few writers, even Frenchmen, spell correctly) was remarkable among his countrymen for his knowledge of other languages than his own, and his recognition of the works of foreign ornithologists stands out in great contrast with that accorded to them by most continental authors. He translated into French several valuable papers written in Swedish and other tongues as little known, thus bringing them before readers to whom they would have been otherwise inaccessible, while he still further showed his appreciation of foreign naturalists by introducing into his principal work portraits of Johann Friedrich Naumann and William Macgillivray as the representative ornithologists of Germany and Great Britain. The earliest performance by which M. Olphe-Galliard will be remembered was his description in the *Annales* of the National Society of Lyons for 1852 of the interesting Algerian bird which he called *Erithacus Moussieri*, after a French army-surgeon of that name who had recognised it as a new species in 1846. In the following year specimens of it were procured by the late Mr. Louis Fraser, and placed in the British Museum, but they met no kind reception there then, or even later, for the species finds itself in the *Catalogue of Birds* (vii. p. 20) far removed from what all naturalists who have observed it in life declare to be its nearest relations—the Stonechats or the Redstarts—and shot into the rubbish-hole placarded *Timeliidæ*, where no one would ever think of looking for it. M. Olphe-Galliard's latest publication consisted of letters addressed to him by the somewhat eccentric Christian Ludwig Brehm, which appeared in the *Ornithologisches Jahrbuch* for 1892.

A MEETING of conchologists is to be held at 67, Chancery Lane, on Monday, February 27, at 8 p.m., for the purpose of founding a "Malacological Society of London."

THE Geologists' Association has arranged for a visit of the members to the British Museum (Natural History), Cromwell Road, on March 18, when Mr. W. Carruthers will give a demonstration on "Gymnosperms from the Devonian to the present time." There will be an excursion to Norwich, Cromer, and Lowestoft at Easter.

SOME admirable suggestions for the guidance of teachers of evening classes in wood-working under the direction of County Councils have been prepared by the Examination Board and Committee of the City and Guilds of London Institute. The suggestions relate to drawing lessons, object lessons, and bench-work lessons.

THE type of weather during the past week has undergone but little change from that of the preceding week. Anticyclonic areas lay over Scandinavia and Spain, and low pressure systems continued to skirt our north and west coasts. The general conditions, however, were much quieter, although a deep depression reached the west of Ireland on Sunday, causing gales on our western coasts. On Tuesday a large and important disturbance arrived over the south-west of England from off the Atlantic, and the wind circulation around its central area was complete. The difference of barometric pressure was, however, by no means large in different parts of the kingdom, and consequently there was not much wind. The barometer fell as low as 28·7 inches over the centre of the cyclonic area, and later during the day the disturbance continued its passage across England, and was accompanied by heavy rain. Temperature continued high for the season, the daily maxima ranging generally from 45° to 55°, while on Sunday, the 19th inst., the thermometer rose to 60° in the inland parts of England. In London it reached 59°, which was a higher reading than had been recorded so early in the year since 1878. The sky was exceptionally brilliant in the east and south-east on that day, but on the whole the air has been very damp throughout the week, and rainfall has been of almost daily occurrence. For the week ended the 18th inst. the rainfall exceeded the mean in all districts, except in the east of England. In the west of Scotland and the south-west of England the excess was considerable. Bright sunshine only exceeded the normal amount in Ireland and the north and east of Scotland.

THE Pilot Chart of the North Atlantic Ocean for February, 1893, shows that the weather in the North Atlantic during January was not abnormally severe, and that the eastern part of the ocean was unusually free from storms. A map is given illustrating the great size and severity of the hurricane of December 22 last, which had moved rapidly from Hatteras in an east-north-east direction. At the time selected for illustration, when the centre lay in longitude 36° west, the storm area covered the entire Atlantic from Labrador and Nova Scotia to Madeira, Portugal, and Ireland. Some very low barometer readings were recorded, the lowest being 27·75 inches. There was a large amount of ice during January along the coast of

America, as far south as Hatteras; in Chesapeake Bay it was reported to be thicker than for twenty-five years.

THE official report of the International Meteorological Conference at Munich from August 26 to September 2, 1891, has now been issued. It contains protocols of the various meetings, with appendices and supplements.

THESSALY was supposed to have got rid of the plague of field mice, but it appears that the congratulations offered to her were somewhat premature. The Athens correspondent of the *Times* telegraphs that swarms of these troublesome creatures are beginning to reappear both in Thessaly and in the neighbouring district of Phthiotis. "It was hoped," he says, "that the severe cold and heavy rains of the last few months had exterminated them, but they seem to have taken refuge in the mountains, and are now returning in large numbers to the plains. The Prefect of Phthiotis has applied to the Government for instructions as to the best means of dealing with this destructive pests."

ACCORDING to a correspondent of the *Scotsman*, writing from Borthwickbrae, Selkirkshire, the mice pest in Scotland has greatly diminished, if it has not entirely disappeared, during the last two months. "The great abundance of owls," he says, "coupled with the very severe weather, has no doubt given them a check." During the severe storm of last month the owls, unfortunately, suffered also. The keeper at Alemoor Loch counted over thirty of the short-eared or heather owl, and eight kestrel hawks—some lying dead, others able to fly a few yards only, while several sat until lifted in the hands. The short-eared owls did not go to the woods to roost, which were close to the loch, but were in the willows and reeds along the edge of the loch.

SIR EDWARD BIRKBECK has accepted the presidency of the British Sea-Anglers' Society, which was founded recently at a meeting held in London. It is proposed that the Society shall have branches in all parts of the United Kingdom, and the members hope that they may be able not only to secure for themselves certain advantages in connection with their favourite sport, but to be of some public service. The chairman of the preliminary meeting, Mr. C. H. Cook, touched on the question of legislation for the protection of sea-fish. "I hope," he said, "that the anglers will take up the cause of immature sea-fish. Already a movement, to which we may give a strong impetus, is rolling forward in this direction, but it is checked by the trawlers' interests. The harm done by these men is almost incalculable. I have seen their nets within a stone's throw of the shore, in less than three fathoms of water, where they scoop up and destroy the infant fish by the million. It may be that the evidence tendered by trustworthy members of the Sea-Anglers' Society may be the means of putting an end to inshore trawling. I hope it will. It often happens that the information given to the Fishery Boards is wilfully misleading, owing to it being given by fishermen, who fear they will lose their living."

THE Council of the Cremation Society of England, in its Report for 1892, expresses much satisfaction with the progress made by the cause which the Society represents. It seems that within the year no fewer than 104 bodies were cremated, "including a large proportion of individuals well known in society by their connection with art, science, or literature, or by a distinguished position of some other kind, ten having been members of the medical profession."

MR. A. H. S. LUCAS, who has edited the *Victorian Naturalist* admirably since it was started nearly nine years ago, has tendered his resignation in consequence of his election to the head-mastership of Newington College, Sydney. The Field Naturalists' Club, of Victoria, to which the magazine belongs, has expressed its cordial thanks to Mr. Lucas for his services. Mr. F. G. A. Barnard, who has been both secretary and librarian of the club, will act for the present as Mr. Lucas's successor.

A MOST interesting and suggestive paper on "pottery glazes: their classification and decorative value in ceramic design" was read by Mr. W. P. Rix at the meeting of the Society of Arts on February 7. It is printed in the current number of the Society's Journal. Mr. Rix tries to show that the relative merit of various glazes is based upon certain optical principles, which have only been partially examined by men of science, and that these principles, underlying the pleasurable sensations to the eye, really govern that which we are pleased to call good taste and excellence, so far as glazes are concerned, and are not mere matters of opinion. The reading of the paper was followed by a lively discussion, in the course of which Mr. Binns quoted a saying attributed to Mr. Gladstone, that a fine piece of glaze "feels like the touch of a baby's hand." Mr. Binns had often been struck with the aptness of the illustration. There was a peculiar soft texture in a fine piece of glaze that only a connoisseur could appreciate.

THE *Times* of Tuesday gives an account of a process by which anthracite coal bricks are now being manufactured. The bricks are made of grains of anthracite dust, which are forced to cohere by means of a special cementing compound and by great pressure. The coal dust is mixed with the binding material in the proportion of 96 per cent. of the former to 4 per cent. of the latter. The compound is fed into a mixer, where it meets a jet of steam, a stiff paste being formed, which is delivered successively into a series of moulds under a pressure of 25 cwt. As the mould plate revolves, the charge in each mould is brought between two rams, which exert a pressure of two tons per square inch on each side of the charge, forming a very dense and homogeneous coal brick. The brick, still in the mould, passes on to the delivery ram, by which it is pushed out on to a table, and is removed for the market. These coal bricks are said to make an excellent fuel and to possess a very high efficiency for steam-raising purposes. The *Times* thinks that with such a fuel at the disposal of the public there is room to hope for a reduction in the pollution of the atmosphere of towns, as well as a reduction in the coal bills of steamship companies and of steam users generally. It adds that the invention is being worked by the Coal Brick Syndicate, of 2, Trafalgar-buildings, Northumberland Avenue, London.

IT seems that serious depredations have been committed among the recently-discovered Phœnician tombs at Gebel Imtarfa, in Malta. The *Mediterranean Naturalist* says that the manner in which not only these tombs, but many others, have been rifled of their contents by irresponsible curiosity hunters, and the state in which many of the ancient ruins of the islands now are constitute a disgrace to European archæological science. More has been done to obliterate and destroy vestiges of Malta's ancient history during the last two centuries than was effected in the preceding two thousand years. Orders have been issued from head-quarters, Valletta, to the effect that the District Commanding Royal Engineer is to report immediately any discoveries of ancient tombs, burial places, or pottery that may occur in course of excavations for works, or come to light in any way; and that such objects are to be carefully preserved until they have been inspected by an officer of the Civil Government, and left untouched *in situ* until this inspection has been made.

A DISCUSSION on Mr. E. G. Carey's paper—to which we lately referred—on the bridges of the Manchester Ship Canal is

reported in the new instalment of the Transactions of the Institution of Engineers and Shipbuilders in Scotland. Mr. Carey, in the course of his reply to the various speakers, alluded to the question as to the value of annealing steel. He said that, so far as his experience went, annealing steel certainly removed all stress. At the Forth Bridge they were very curious about this subject. They had a single strip of steel, which they strained up to some 30 times, to about 25 tons on the square inch. After every straining, it was annealed. That went on for days and weeks, and the steel seemed to be literally the same as when they started. The experiment grew wearisome, and ultimately, when the strain was run up inadvertently to about 30 tons per square inch, and the specimen finally broke, it was almost a relief, but it proved that the annealing of steel removed all strain, and that, although injured, if annealed, it seemed to recover its former properties.

A VALUABLE synonymic and bibliographical catalogue of the New Zealand land and freshwater Mollusca, by H. Suter, was communicated to the Linnean Society of New South Wales at its meeting on December 28. In 1880 Prof. Hutton, in his "Manual of the New Zealand Mollusca," enumerated 125 species of land, fresh, and brackish water molluscs. Since then zoology has made such rapid strides that this fauna is raised in Mr. Suter's catalogue to a total of 178 species, divided by him into 45 genera. The land mollusca embrace 142 species, of which 15 are operculate; the fluviatile shells are reckoned at 32, 12 being bivalves and 7 operculate univalves. This large addition of one-third to the list of twelve years ago is not the greatest advantage the present catalogue has over its predecessor; numerous species are now removed which, by the negligence of collectors or the errors of European authors, were formerly included among the shells of New Zealand. The attention bestowed during the last decade upon the anatomy of the New Zealand snails has furnished data for a more natural classification, while the increase of colonial libraries has facilitated the quotation of fuller references than were previously available.

MR. J. M. STAHL, Illinois, has much to say in the *American Agriculturist* about the virtues of wood ashes. Speaking of them as a medicine for farm animals, he says he has found them of great value. He has raised swine rather extensively for more than twenty years without cholera or swine plague, and has not lost one per cent. of his hogs from disease. He keeps wood ashes, and charcoal mixed with salt, constantly before his swine in a large covered box with holes two-by-six inches near the bottom. The hogs will work the mixture out through these holes as fast as they want it. He selects ashes rich in charcoal, and mixes three parts of ashes to one of salt. There is no danger of the swine eating too much of this mixture, or of pure salt, if it is kept constantly before them, and they are provided with water. The beneficial effects of the mixture are quite marked, especially when the hogs are fattened on fresh maize. A little wood ashes, given to horses, is also, he maintains, very beneficial. In thirty-seven years' experience upon the farm he has lost but one horse, and this was overheated in the horse-power of a threshing-machine during his absence, and the only "condition powder" he has ever used has been clean wood ashes. The ashes may be given by putting an even teaspoonful on the oats twice a week, but he prefers to keep the ashes and salt mixture constantly before the horses, and has made for it a little compartment in one corner of the feed box. His experience is that the best condition powder is a mixture of three parts wood ashes to one of salt; and that when it is given regularly, and reasonable care and intelligence are used in handling the horse, no other medicines are necessary. Mr. Stahl has also great faith in the efficacy of wood ashes as a fertiliser.

A VALUABLE paper on the industrial resources of the Caucasus, by an Austrian official, Herr G. Sedlaczek, is summarised in the Board of Trade Journal for February. Dealing with the silk industry, the author says that the Russian Government has spent more money for the furtherance of this department of trade than for any other industrial purpose in Caucasia, and that the results are in no way commensurate with the trouble and outlay. Although the country possesses innumerable mulberry trees, in some parts forming veritable forests, and excellently suited for feeding silkworms, although the climatic conditions are favourable, and the inhabitants have from time immemorial been familiar with the working up of the raw material, the most untiring efforts of the Government have proved little else than a struggle to preserve the mere existence of the silk culture and industry. The estimated production of silk in Transcaucasia at the present day is 36,000 pouds, although in 1855 it was 30,000 pouds. The average value of the produce is said to be about 6,000,000 roubles. Considerable advance has been made in reeling, spinning, and twisting; new foreign machinery is everywhere at work, and all that is wanting is a good raw material, the production of which is, however, being constantly prevented, on the one hand by disease in the worms, and on the other by the indolence of the producers. The Russian demand for silk is far from covered by native production, silk being annually imported to the value of about 12½ millions of roubles, while the exports amount only to about 3,000,000 roubles in value. In spite of protective duties the imports are increasing while the exports are decreasing.

MANY marine animals (radiolaria, ctenophora, &c.) rise and sink slowly in the water, having some means, apparently, of changing their specific gravity. This has been recently studied by Herr Verworn (*Pflüger's Archiv*), in the case of *Thalassicolla nucleata*, a radiolarian about the size of a pea. It has a central capsule with nucleus, a coarse endoplasm, a vacuole-layer, a gelatinous-layer, and ray-like processes. As a rule, these animals float at the surface. They sink on seizing food heavier than themselves, also when strongly stimulated by shaking, or by chemical agents. It was found that the central capsule and the gelatinous layer are both heavier than sea-water, while the vacuole-layer is lighter. On being stimulated, the pseudopodia (or processes) were drawn into the vacuole-layer, and the protoplasm also retired from this, the walls of the vacuoles flattening from without inwards, till at length very little of them was left. Then the animal began to sink. At the bottom the vacuoles were soon regenerated, and the animal rose again. Thus it appears that the vacuole-layer is the hydrostatic apparatus of these organisms, the vacuole liquid being that part of the cell which is lighter than sea-water, and keeps the cell at the surface. The same probably holds good with other pelagic animals. That the vacuole-liquid is lighter than the sea-water from which it comes is no difficulty, since it is known that living protoplasm is impermeable for many salts.

A VOLUMETRIC method for determining the amount of chromium in a specimen of steel has become a great metallurgical desideratum since the good qualities conferred upon steel by its addition have become generally known. Such a method is described by G. Giorgis, of the University of Rome, in the *Atti* of the *Accademia dei Lincei*. It is founded upon the formation of potassium chromate and hydrated manganese sesquioxide on adding a solution of potassium permanganate to a solution of sesquioxide of chromium in potassium hydrate. Ten grammes of the steel are dissolved in a mixture of sulphuric and nitric acids (3 to 1), the solution is made up to 1 litre with distilled water, and 250 c.c. are made just alkaline with sodium hydrate, and treated with hot permanganate of potash till the solution assumes a red colour. After cooling the whole is

poured into a flask of 500 c.c. capacity, filling up with water. 400 c.c. are filtered through a dry filter, acidified with sulphuric acid, reduced by SO_2, and concentrated to 200 or 100 c.c., according to the quantity of chromium probably present. Donath's method may then be employed, consisting in the addition of the chromium salt prepared as above described, to a measured quantity of a standard permanganate solution, and watching for the golden yellow colour assumed by the mixture when the permanganate is all dissolved, *i.e.* when all the chromium exists in the form of a chromate, from which the amount of chromium is easily calculated. It is said that this process is extremely accurate, and requires only a small fraction of the time required by gravimetric methods.

THE subject of dew appears to be still involved in some controversy. An experimental contribution to it has been recently made by Herr Wollny (*Forschungen*, &c.), who used plants in glazed pots with earth of varying moisture, some of these being allowed to radiate freely on favourable nights, while others were screened. The following is a brief outline of Herr Wollny's views :—Dew depends partly on evaporation from the ground, partly on transpiration. It is at present doubtful whether precipitates from the air share in it or not. A cloudy sky weakens the cooling process without stopping it wholly. With copious radiation, the temperature minimum is at the surface of the plant-covering (of the ground), and here the aqueous vapour rising from the warm ground is partly precipitated. With increase of the ground-heat downward there is increase of the water brought up by the plants, which is given up as vapour and condensed. The more moisture there is in the ground, the more water is evaporated from the ground and the plants. Dew formation is usually favoured by the larger number of stomata on the under surface of leaves than on the upper. On a given surface of ground the dew is more plentiful the stronger the plant organs above ground, and the closer the plant growth. The temperature of still air increases from the surface to a certain limit (at about 5 feet over grass it was sometimes 4° or 5° C. warmer than on the ground). In experiments with blotting paper, cotton wool, feathers, and asbestos, the first was much moistened, while the others showed dew in drops. Bodies of organic origin attract more moisture than those of mineral (a case of hygroscopic absorption). For vegetation, the author considers the benefit of dew but trifling. Of the whole annual precipitation at Munich dew only gave 3·23 per cent.

WITH the present year the weekly *Botanische Zeitung* enters on the fifty-first year of its existence, and Graf zu Solms-Laubach gives with the first number of the year an interesting sketch of its history, uninterrupted for half a century, even during the stormy period of 1847–1849. The inception of the undertaking was due to the suggestion of a botanist still living, Dr. Carl Müller, of Halle. The first number of the *Botanische Zeitung* appeared on January 9, 1843, under the editorship of Von Mohl and Schlechtendal. The editorial chair has been occupied since then by some of the most distinguished German botanists, De Bary, Hallier, Kraus, Jost, and the present editors, Solms-Laubach and Wortmann.

DR. VINES, the Professor of Botany in the University of Oxford, has for some time past had in preparation a "Student's Text-book of Botany," which will be more comprehensive than his edition of Prantl's well-known "Elementary Text-book." It is to be fully illustrated, and is expected to be ready early in the autumn of this year. It will be published by Messrs. Swan Sonnenschein and Co.

MESSRS. GAUTHIER-VILLARS ET FILS, Paris, continue to issue the useful series of small volumes called "Encyclopédie Scientifique des Aide-Mémoire." The following volumes have lately been added: "Corderie," by M. Alheilig; "Formation des Gîtes Métallifères," by L. de Launay; "Le Grisou," by M. Le Chatelier; "Moteurs à Vapeur," by M. Dudebout; "Détente Variable de la Vapeur," by A. Madamet; "Canons, Torpilles, et Cuirasses," by A. Croneau; "Textiles Végétaux," by H. Lecomte; "Essais d'Or et d'Argent," by H. Gautier; "État Actuel de la Marine de Guerre," by L. E. Bertin; "Industrie des Cuirs et des Peaux," by Ferdinand Jean.

THE "Annuaire," for 1893, of the Royal Observatory of Belgium, by F. Folie, has been published. This is the sixtieth year of issue.

THE Department of Science and Art has issued the volume for 1893 containing its calendar, history, and general summary of regulations.

IN the course of an elaborate investigation recently published in the *Zeitschrift für Hygiene*, December 9, 1892 ("Die Aetiologie des infectiösen fieberhaften Icterus" (Weil'sche Krankheit), Jaeger draws attention to the dangers which may arise from bathing in polluted water. Already in 1888 Pfuhl (*Deutsche militär-ärztl. Zeitschrift*, 1888, Heft 9 and 10) attributed an outbreak of typhoid fever, accompanied by jaundice, which occurred amongst the garrison stationed at Altona to bathing in the Elbe, which at the time was described as more than usually polluted. Hüeber and Globig came to similar conclusions with regard to outbreaks of the above "Weil'sche Krankheit," which appeared at Ulm on the Danube and Lehe respectively. Jaeger has made a special study of the cases which arose amongst the soldiers at Ulm, and has endeavoured to trace, if possible, the infection to its source. It was found that the military bathing-place was situated below the point where the Danube is joined by the highly-polluted river Blau. This stream is described as being practically an open sewer, and even before it reaches Ulm is stated to be grossly contaminated in its flow through the small village of Söflingen. It was further ascertained that in this village for many years a mysterious disease had been rife amongst the ducks and geese, whilst fowls were also occasionally attacked, and that moreover it was a common custom to throw the dead carcases of these animals into the Blau as the readiest means of getting rid of them. A careful examination of some of the birds which had succumbed to this disease revealed the constant presence of a micro-organism, which Jaeger asserts was identical with that found repeatedly and isolated in the cases of icterus investigated by him at Ulm. It is further stated that by mixing some of the highly-polluted Blau water at Söflingen with sterile broth, and inoculating it into white mice, they were killed in sixteen hours, and that the organism, which was found abundantly present in various organs of the body, was in every respect identical with that previously isolated in the cases of icterus at Ulm, and from the carcases of the birds at Söflingen. Taking these various results into consideration Jaeger is of opinion that they afford very strong evidence of the virus of this disease having been introduced into the highly contaminated stream at Söflingen, and conveyed thence to the military bathing-place, which, as already mentioned, is situated below the junction of the Blau with the Danube. In consequence of the appearances in cultivations to which this organism gives rise, the author has suggested for its name *Bacillus proteus fluorescens*, and claims in it to have discovered the exciting cause of the so-called "Weil'sche Krankheit," the etiology of which is attracting much attention on the continent.

NOTES from the Marine Biological Station, Plymouth :—Heavy gales have prevailed for many weeks, confining operations to the inshore waters. The week's captures include numbers of the Archiannelid *Dinophilus tæniatus*, of the Polychæta *Marphysa*

sanguinea and *Sigalion boa*, and of the Nudibranch *Ancula cristata*. In addition to the forms mentioned last week, the townettings have contained the Siphonophore *Muggiæa atlantica*, the Anthomedusa *Margellium* (*Lizzia*) *octopunctatum*, and several ephyræ of *Aurelia*, together with numbers of Teleostean ova, Prosobranch and Opisthobranch veligers, larval Lamellibranchs and *Cyphonautes*-larvæ. The Polychæte *Cirratulus cirratus* and Gastropod *Littorina littoralis* are also breeding.

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented by Mr. Walter Neall; two Red and Yellow Macaws (*Ara chloroptera*) from South America, presented by Mr. Henry Goschen; a Herring Gull (*Larus argentatus*) European, presented by Mr. W. R. Galbraith; a Bar-breasted Finch (*Munia nisoria*) from Java, presented by Mr. Sydney D. Birch; two Whooper Swans (*Cygnus musicus*) European, purchased; a Vulpine Phalanger (*Phalangista vulpina*), three Barbary Mice (*Mus barbarus*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET BROOKS (NOVEMBER 19, 1892).—The following ephemeris for Comet Brooks is taken from *Astronomische Nachrichten*, No. 3142:—

1893.	R.A. (app.) h. m. s.	Decl. (app.) ° ′
Feb. 23 ...	0 31 49 ...	+24 18·2
24 ...	33 0 ...	23 59·8
25 ...	34 9 ...	23 42·1
26 ...	35 17 ...	23 25·0
27 ...	36 24 ...	23 8·5
28 ...	37 30 ...	22 52·4
March 1 ...	0 38 34 ...	22 36·8

COMET HOLMES (1892 III.).—Several communications with respect to the late appearances of this comet are inserted in the Comet Notes of *Astronomy and Astrophysics* for February, among which will be found one by Prof. E. Barnard. Observing with a 12-inch on the night of January 16, at 8h. 10m., he found that an estimation of the comet's diameter gave 30″, while a setting of the wires indicated 29″·4. While under observation "*the comet seemed to be perceptibly brightening*," and further measurements at 9h. 45m. gave a diameter of 32″·4. At this time he says: "The nucleus had developed clearly, and was very noticeable as a small, ill-defined star." With the 36-inch, which he was able to use later, he made the following measures, which we reproduce here, as they are quite unique in showing the increase in diameter of a comet due evidently to some external impact:—

Standard Pacific time. h. m.	Diameter. ″
10 29	43·4
10 30	44·9
10 31	43·6
10 42	47·8
10 43	47·9
10 45	46·0
11 13	47·3
11 15	46·1

In concluding his remarks he says: "This is certainly the most remarkable comet I have ever seen, taking everything into consideration."

The following is the ephemeris for this week:—

Greenwich, Midnight.

1893.	R.A. (app.) h. m. s.	Decl. (app.) ° ′ ″
Feb. 23 ...	2 19 4·4 ...	+34 31 7
24 ...	20 44·6 ...	33 36
25 ...	22 25·5 ...	36 9
26 ...	24 6·4 ...	38 42
27 ...	25 48·0 ...	41 18
28 ...	27 29·6 ...	43 54
March 1 ...	29 11·9 ...	46 34
2 ...	2 30 54·3 ...	34 49 13

SOLAR OBSERVATIONS AT ROME.—In the *Memorie Degli Spettroscopisti Italiani* for January, Prof. Tacchini communicates the observations made at the Royal College with respect to the various phenomena observed at the solar surface during the third trimestre of 1892. Dealing first with the prominences the total number for each of the months are respectively for north latitudes, 182, 129, 120, total 431; and for south latitudes 141, 167, 185, the total number here amounting to 493. The balance here is in favour of the southern hemisphere for greater frequency, but a curious fact may here be remarked, and that is that the maxima for the north and south latitudes occur in the months of July and September respectively, each exceeding considerably the number of prominences recorded for the same month in the opposite hemisphere.

The greatest frequencies occurred in latitudes ($+60°+70°$) and ($-50°-60°$). The groups of spots seem to have predominated slightly in the southern latitudes, the record showing 49 against 41; at the equator as many as 13 for zone ($0°+10°$) were seen, the zone ($0°-10°$) showing only 4; the relative frequency occurred here in the same zones in both hemispheres ($\pm 10° \pm 20°$).

With reference to eruptions, the month of July contains the only records, six for the northern, and three for the southern hemisphere, four of these taking place in zone ($+10°+20°$).

Prof. Tacchini also has a note on the great prominence of November 16 last, in which he describes in detail the numerous observations which he was fortunate to procure. Although one can gather a good idea of the rapidity of the ascent from the table, the figures which accompany it show in a striking manner the great changes of shape that was such a conspicuous feature in its ascent. At 9h. 0m. on the 16th the height was only 131″·8, but at 1h. it had reached 319″·2, and at 1h. 35m., 534″·3, this being its maximum height. It is interesting to notice the numbers showing the increase of altitude in *one* minute of time.

For instance, at 11h. 55m. the increase of altitude per minute was 0″·56, at 1h. 4m. it was 6″·75, decreasing from this value to 4″·34 at 1h. 27m. At 1h. 32m. the velocity of ascent was increased, the value amounting to 9″·72, but at 1h. 34m. the increase of altitude reached its maximum, 20″·80, showing the ascent per minute.

THE STAR CATALOGUE OF THE "ASTRONOMISCHE GESSELSCHAFT."—The Harvard College Observatory has now completed the task of cataloguing the zone of stars undertaken in connection with the great catalogue of the *Astronomische Gesselschaft*. The stars included number 8627, and lie between 49° 50′ and 55° 10′ north declination, and the positions are reduced to the epoch 1875. Most of the observations were made by Prof. Rogers during the years 1870–1884, and the reductions have throughout been in his charge. The publication appears simultaneously as vol. xv. part ii. of the *Annals of the Harvard Observatory*, and as one of the volumes of the *Gesselschaft*. All concerned are to be congratulated on the completion of the zone, which involved over twenty-six thousand observations and an immense amount of calculation.

NOVA AURIGÆ.—Mr. Fowler draws attention to the fact that the nova is still as bright as ninth magnitude, and therefore easily visible in comparatively small telescopes. Its spectrum seems to consist of the two bright nebula lines near wave-lengths 5006 and 4956. The latter is only slightly fainter than that at 5006.

PARALLAX OF β CYGNI.—Mr. Harold Jacoby, whose work on the reduction of the Rutherford photographic measures of the stars about β Cygni we have previously referred to, suggests in *Astronomical Journal*, No. 287, that the discrepancies in the results can be explained on the hypothesis of a parallax of β Cygni amounting nearly to a whole second of arc. To investigate this he has chosen five pairs of comparison stars, from which he has computed the parallax from each pair separately by "using the difference of the distances of the two comparison stars from β as the quantity from whose variation the parallax should appear;" in this way he has obtained the weighted mean for the parallax to be + 0″·97, a value which, if endorsed by further observations will show us that of all stars β Cygni is one of our nearest neighbours.

GEOGRAPHICAL NOTES.

MR. G. B. GRUNDY, of Brasenose College, the student in geography appointed jointly by the University of Oxford and the Royal Geographical Society, has made a careful survey of the battlefield and site of the town of Platæa and of Leuctra,

in Greece. He is now engaged in preparing a comprehensive memoir on the subject which may be expected to throw new light on some questions of historical geography.

MR. MACKINDER, in his fifth lecture for the Royal Geographical Society's education scheme, spoke of the chief lines of communication between Asia and Europe and the ways by which successive bands or hordes of Asiatic invaders forced a passage into the heart of Europe. The routes across Asia Minor from the Gate of Cilicia to the northern waters, and the thoroughfare through the Balkan peninsula now traversed by the international railway, were shown to have guided the movements of peoples and the formation or dissolution of nations from the dawn of European history on to the present day.

THE United States appears to have entered the field as an aggrandising power, taking up territory beyond the limits of the continent of North America. The annexation of Hawaii seems likely to be effected without remonstrance, and a footing has also been obtained in San Domingo, the eastern part of the island of Haiti.

MR. A. VAUGHAN WILLIAMS has been exploring the region round the mouth of the Sabi River in south-east Africa. He has ascended the stream for thirty miles to the limit of tidal influence.

THE orthography of African place names is a perpetual source of confusion. It appears that in place of Zimbabwe or Zimbabye we ought, in order to render the sound of the word used by the people surrounding the ruins, to write "Zimbabghi." The familiar name Mashonaland is in itself a corruption of the native name, but is always pronounced Mashunaland, a pronunciation to which the spelling ought to conform.

RAILWAYS seem likely at last to become established in China. The line from Teintsin to Taku has now been extended to the River Lan, a total distance of 130 miles, and is being rapidly pushed northward, a considerable section being already opened for passenger traffic.

CAPTAIN BOWER'S JOURNEY IN TIBET.

AT an extra meeting of the Royal Geographical Society, on Monday night, Captain H. Bower described his recent journey with Dr. Thorold across Tibet from west to east. They set out from Leh on June 14, 1891, and were fortunate enough to get well into Tibet before meeting any natives. Travelling due east they crossed a pass of 18,400 feet, on the other side of which lay the Horpa Cho, the highest lake yet met with in Tibet, and probably the highest in the world, its altitude being 17,930 feet. Along the route eastward many other lakes were passed, all salt and without outlet, the want of fresh water being sometimes severely felt; a kettleful of hailstones was a welcome catch on one occasion. The travellers used ponies and donkeys for carrying their loads, as yaks do not eat grain, and grass was often not met with for many days' journey. At length, after travelling east and south-east for about 700 miles, they were stopped within 200 miles of Lhasa by the Tibetans, who paid no attention to Chinese passports, and after much parleying insisted on a complete change of route. The party had to retrace their steps for several days' march, turn northward, and then make their way east at a safer distance from the capital. It was now the month of October and the crossing of passes over 18,000 feet, with temperatures of 15° or more below zero, in strong wind was extremely trying. About the end of November, for the first time for four months, the tents were pitched at a less altitude than 15,000 feet, and soon afterwards Chiamdo was reached. Here great difficulty was experienced with the lamas, who insisted that no European should enter the town; but by the intervention of the Chinese Amban, whose power was really but slight, the party was allowed to proceed, passing round the outside of the town. From Chiamdo to Batang the way was easy, and no difficulties were experienced thereafter. At Ta-Chen-Lu they entered China and reached Shanghai on March 29, 1892. Throughout Central Tibet the authorities disclaimed the sovereignty of China, maintaining that only the grand lama had jurisdiction in that region. Many of the lamas met with were educated and intelligent men, but not inclined to give information. Much difficulty was experienced in getting the names of lakes and mountains, no two Tibetans giving the same answer. The fanaticism and distrust of the people created constant difficulties, but Captain Bower, under the pretext of being a Buddhist with a peculiar ritual, succeeded in making observations for position openly as part of a religious service, previous attempts to do so by stealth having failed.

THE CHEMISTRY OF OSMIUM.

AN important addition to our knowledge of the chemical nature of this interesting element is contributed by Prof. Moraht and Dr. Wischin, of Munich, to the current number of the *Zeitschrift für Anorganische Chemie.* Two years have scarcely elapsed since the position of osmium in the periodic system was finally decided by the painstaking re-determination of its atomic weight by Prof. Seubert. Previous determinations of the atomic weight of osmium had been made with material which Seubert subsequently showed to be impure, and in consequence the erroneous value, 198·6, had been ascribed to it. Indeed previous to the year 1878 the order of precedence as regards atomic weight of the four metals of the platinum group —gold 196·2, iridium 196·7, platinum 196·7, and osmium 198·6 —was entirely at variance with the order demanded by their chemical and physical properties, and a standing contradiction of the periodic law of Newlands and Mendeleef. In that year, however, Seubert attacked the case of iridium, and as the result of a series of determinations, made with the laborious care which has characterised all his work, the atomic weight of this metal, when obtained in a pure state, was shown to be 192·5, a number very different to that previously assigned to it, and which was afterwards remarkably confirmed, even to the decimal place, by an independent investigation by Joly. Three years later Seubert made his celebrated re-determination of the atomic weight of platinum, which resulted in the number 194·3 being finally derived for the true atomic weight of the perfectly pure metal. This value was likewise subsequently confirmed by Halberstadt. In the year 1887 the position of gold was decided by simultaneous independent re-determinations of its atomic weight by Thorpe and Laurie in this country and Krüss in Germany, the two values being practically identical, 196·7. Lastly, in 1891, Seubert completed his work by re-determining the atomic weight of osmium with a specimen of the metal of practically perfect purity, with the result that the old number, 198·6, was found to be entirely erroneous, due to considerable quantities of impurities being present in the samples previously employed, and that the real value of this constant was 190·3, thus removing osmium from its former situation at the end of the series and placing it in its proper position at the head of it.

The order of precedence of the metals of the platinum group is therefore as follows:—Osmium 190·3, iridium 192·5, platinum 194·3, and gold 196·7. This order is in full accordance with the relative chemical and physical properties of these metals, and the last outstanding exception to the periodic generalisation has disappeared.

Although the properties of pure metallic osmium, and particularly its atomic weight, are now known with certainty, the nature of its compounds is yet very little understood. Moreover, it is evident from the result of the investigation of Prof. Seubert that previous workers have been dealing with an impure metal of atomic weight, 198·6. It was therefore desirable that not only should the chemistry of this element be extended to compounds hitherto uninvestigated, but that the composition and properties of the compounds already known should be subjected to a re-examination.

Prof. Moraht and Dr. Wischin have therefore taken up the study of the compounds of osmium with oxygen, sulphur, and the halogens, employing material of a very high degree of purity, and the results of their investigation are both novel and interesting.

Work with osmium compounds is endowed with peculiar personal danger to the chemist, owing to the great facility exhibited under the most various conditions for the formation of the tetroxide OsO_4, a substance which boils at 100° C., and is very volatile at the ordinary temperature, and which attacks the skin, the lungs, and particularly the eyes with most serious consequences.

The material started with was a comparatively pure sample of the best known salt containing osmium, potassium osmate, $K_2OsO_4.2H_2O$. This salt was further purified by distillation

with nitric acid or aqua regia and absorption of the liberated tetroxide vapours in a solution of caustic potash. The dark brown solution of potassium perosmate thus formed was largely diluted with water, and reduced to osmate by the addition of alcohol. After the expiration of about twenty-four hours almost the whole of the osmium had separated in the form of beautiful little crimson octahedrons of the salt $K_2OsO_4.2H_2O$, which, after washing with dilute alcohol, proved to be quite free from impurity, showing no trace of iridium.

Previous observers have noticed that an aqueous solution of *potassium osmate*, K_2OsO_4, is most remarkably affected by sunlight, a rapid decomposition being brought about with deposition of a black precipitate to which the composition $OsO_2.2H_2O$ has been ascribed. The specimens experimented with, however, undoubtedly contained iridium, and it was therefore of interest to investigate the action of sunlight upon solutions of the pure salt just described. When the crimson octahedrons of pure $K_2OsO_4.2H_2O$ were dissolved in cold water, and the clear reddish violet-coloured solution was exposed to direct sunshine, no evidence of change was apparent for several days, but the moment the vessel containing the solution was immersed in a bath of boiling water, while in bright sunshine, decomposition commenced, and a black precipitate rapidly accumulated, until after the expiration of two or three hours the whole of the osmium present was deposited. As there is a marked tendency for the production of the noxious fumes of osmium tetroxide during this decomposition of the hot osmate solution by the waves of light it is best to take the precaution of reducing their amount to a minimum by the addition of a little alcohol, which acts as a strong reducing agent under these circumstances, and by passing a stream of hydrogen through the solution during the whole operation. The precipitate is usually so finely divided that considerable difficulty is experienced in separating it from the solution. The filtration succeeds best when the filter is previously moistened with dilute acetic acid, when a clear colourless filtrate is usually at once obtained. The precipitate cannot be dried in a warm air bath, as it is largely converted thereby into the volatile osmium tetroxide. It may safely, however, be dried over phosphoric anhydride in the vacuum of an air-pump.

The accurate analysis of an insoluble substance of the nature of this precipitate, and containing a metal such as osmium, which so readily oxidises to the volatile tetroxide, is a task of exceptional difficulty. The usual method of reduction to metal in a stream of hydrogen is insufficient, for more or less of the tetroxide is always formed during the process, necessitating the use of an absorption apparatus containing a solution of caustic potash, placed in front of the tube containing calcium chloride to absorb the water formed. The difficulty is, then, how to estimate the small quantity of osmium thus dissolved in the large excess of alkali. It was eventually found that the weak electric current from three Daniell's cells precipitates the whole of the osmium from such a solution, contained in a nickel dish which forms the negative electrode, in the form of pure *osmium dioxide*, OsO_2, which may conveniently be dried *in vacuo* over phosphoric anhydride and weighed as such.

By this mode of analysis the interesting fact was eventually elicited, that the black insoluble substance formed by the action of light upon a hot solution of potassium osmate is not, as was previously supposed, a hydrate of osmium dioxide of the composition $OsO_2.2H_2O$, but is no other than free *osmic acid* itself, the hydrate of osmium trioxide, $OsO_3.H_2O$ or H_2OsO_4. Osmic acid is thus formed by the direct action of water, under the influence of sunlight and slight rise of temperature, upon the potassium salt. This remarkable change is expressed by the simple equation:

$$K_2OsO_4 + 2H_2O = H_2OsO_4 + 2KOH.$$

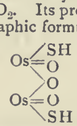
The liquid, as soon as the change commences, is observed to exhibit a strong alkaline reaction, becoming, as indicated in the equation, a solution of caustic potash. It is singular that the presence of alcohol and the passage of a current of hydrogen during the reaction do not cause any reduction, serving only to hinder the further oxidation to the state of tetroxide. Indeed, if the crimson octahedral crystals of potassium osmate are covered in sunshine with warm alcohol and a current of hydrogen is allowed to bubble through the liquid, no trace of blackening is observed upon the faces of the crystals. The moment water is added, however, decomposition is immediately brought about.

Osmic acid, H_2OsO_4, is a soot-black powder, which fumes strongly in moist air, owing to its rapid conversion into the volatile osmium tetroxide, OsO_4, but which is quite permanent at the ordinary temperature when preserved under water containing alcohol. It dissolves readily in nitric acid with formation of the hydrate of osmium tetroxide, the so-called per-osmic acid. Cold hydrochloric acid attacks it but very slightly. Upon warming, however, it is entirely soluble, forming an olive-green liquid, which will be subsequently considered, with liberation of a small quantity of chlorine. Sulphuric acid does not attack it. Osmic acid reacts in a most energetic and interesting manner with sulphuretted hydrogen gas. Even in the dry state at the ordinary temperature the reaction proceeds with considerable violence. If the experiment is conducted in a piece of combustion tubing, upon which a bulb has been blown for the reception of the osmic acid, the moment that the gas enters the tube the whole of the black powder immediately becomes incandescent, and drops of water and a large quantity of free sulphur are deposited in the portion of the tube not heated by the reacting substances. The residual product of the reaction is a brown powder, which has been found to be a hydrated oxysulphide of osmium of the composition $2OsSO.H_2O$.

The reaction occurs in accordance with the equation—

$$2H_2OsO_4 + 4H_2S = 2OsSO.H_2O + 5H_2O + 2S.$$

This *oxysulphide of osmium* is soluble in acids with decomposition, even sulphuric acid decomposing it with evolution of sulphuretted hydrogen. It possesses acid properties, for it liberates carbon dioxide from carbonate of soda and sulphuretted hydrogen when fused with sulphide of potassium. It would, moreover, appear to contain SH groups, for it yields mercaptan upon treatment with soda and ethyl iodide, the osmium being reduced to the dioxide OsO_2. Its probable constitution is therefore represented by the graphic formula:—



When this oxysulphide is warmed in dry sulphuretted hydrogen another violent reaction occurs, the whole mass again becomes incandescent, and the whole of the oxygen is eliminated in the form of water. The product of this second reaction with sulphuretted hydrogen is pure *osmium disulphide* OsS_2.

$$Os_2O_3(SH)_2 + 2H_2S = 2OsS_2 + 3H_2O.$$

Of the *halogen* compounds of osmium only the chlorides have been at all investigated, chiefly by Claus, whose observations may be summarised in a few words.

When finely-powdered metallic osmium is heated in a stream of dry chlorine sublimates are formed. The first chlorine compound formed is chromous-green in colour, but is only produced to a very slight extent. There is next deposited a dense black sublimate, and finally a smaller quantity of a sublimate of the colour of red lead. None of these three chlorine compounds are crystalline. Claus subsequently stated that the lowest chloride OsCl, is a bluish-black solid when isolated, and forms a dark bluish-violet solution; the sesquichloride Os_2Cl_3 is reddish-brown in the solid state, and gives with water a rose-red coloured solution, and the dichloride $OsCl_2$ is the compound which exhibits the colour of red-lead, and yields a lemon-yellow solution

These observations of Claus are completely confirmed by the experiments of Prof. Moraht and Dr. Wischin, who, however, have extended them, and have been able to isolate other and higher chlorides of osmium.

They commenced by warming a large quantity of the free osmic acid above described for two days upon a water-bath with concentrated hydrochloric acid, the flask in which the reaction was conducted being connected with an upright condenser. A little alcohol was added in order to prevent the formation of osmium tetroxide. The osmic acid eventually entirely dissolved with formation of the dark olive-green coloured solution previously incidentally mentioned, a little chlorine being evolved at the commencement of the operation. It was found impossible to evaporate the solution upon the water-bath without decomposition, but evaporation *in vacuo* over sulphuric acid and solid caustic potash, the latter to absorb the hydrochloric acid, succeeded admirably. The solid left after complete evaporation consisted of well formed crystals which assumed the habit of six-sided pyramids. These crystals were dark olive-green in colour when moist, but when the last traces of superfluous water were removed, exhibited a bright vermilion colour. They were readily

soluble in water and alcohol, the solutions being coloured dark green, and the salt may be recrystallised from these solvents. Upon analysis they were found to consist of the chloride Os_2Cl_7 crystallised with seven molecules of water.

This chloride of osmium, $Os_2Cl_7.7H_2O$, would appear to be a molecular compound of the *trichloride*, $OsCl_3$, and the *tetrachloride*, $OsCl_4$. For when potassium chloride solution is added to the solution of the crystals in alcohol, a precipitate of brilliant red octahedrons and cubes of potassium osmichloride, K_2OsCl_6, is obtained, showing the presence of *osmium tetrachloride*, $OsCl_4$. Moreover, when the precipitate is separated by filtration, and the filtrate concentrated by evaporation *in vacuo*, dark green crystals of the *trichloride*, $OsCl_3$, are deposited containing three molecules of water of crystallisation.

During the reduction of these crystals of the trichloride in a current of hydrogen for the purposes of analysis, a small quantity of a white sublimate was obtained, which probably consisted of the *octo-chloride*, $OsCl_8$, corresponding to the tetroxide OsO_4.

Bromine does not react with osmium with anything like the energy of chlorine. The free elements do not appear to combine at all, even at moderately high temperatures. Only a small quantity of a sublimate of a dark brown colour is obtained by passing bromine vapour over osmic acid. This sublimate dissolves to a brown solution in water, which, however, rapidly decomposes with deposition of a black precipitate.

When osmic acid, H_2OsO_4, is treated with hydrobromic acid in the manner just described in the case of hydrochloric acid a similar reaction occurs with formation of a clear reddish-brown solution which yields, upon evaporation *in vacuo* over sulphuric acid and solid caustic potash, small crystals of a molecular compound of the *tribromide*, $OsBr_3$, and the *hexabromide*, $OsBr_6$, together with six molecules of water of crystallisation. These crystals of $Os_2Br_9.6H_2O$ are dark reddish-brown in colour and exhibit a beautiful metallic lustre. They are quite stable when preserved in a dry atmosphere, but rapidly deliquesce in moist air.

Iodine appears to possess even less affinity for osmium than bromine. When, however, osmic acid is treated with hydriodic acid a deep greenish-brown solution is obtained which deposits *in vacuo* dark violet rhombohedrons, exhibiting a brilliant metallic lustre, consisting of the anhydrous *tetra-iodide of osmium*, OsI_4. This iodide, the only one containing osmium yet prepared, is permanent in a dry atmosphere at the ordinary temperature, but rapidly deliquesces like the bromide when exposed to moist air.

In relative stability the chloride bromide and iodide of osmium above described exhibit a gradation such as would be expected from the relations between the halogen elements themselves. The iodide is readily dissociated by slightly raising the temperature, and upon the addition of water is decomposed with the deposition of a black precipitate containing the metal. A similar decomposition occurs, although much more slowly, in case of the bromide. The chloride, however, is well-nigh permanent under these conditions, only exhibiting traces of decomposition after the lapse of a considerable time. A. E. TUTTON.

REDUCTION OF TIDAL OBSERVATIONS.[1]

THE tidal oscillation of the ocean may be represented as the sum of a number of simple harmonic waves which go through their periods approximately once, twice, thrice, four times in a mean solar day. But these simple harmonic waves may be regarded as being rigorously diurnal, semi-diurnal, ter-diurnal, and so forth, if the length of the day referred to be adapted to suit the particular wave under consideration. The idea of a series of special scales of time is thus introduced, each time-scale being appropriate to a special tide. For example, the mean interval between successive culminations of the moon is 24h. 50m., and this interval may be described as the mean lunar day. Now there is a series of tides, bearing the initials M_1, M_2, M_3, M_4, &c., which go through their periods rigorously once, twice, thrice, four times, &c., in a mean lunar day. The solar tides, S, proceed according to mean solar time, but, besides mean lunar and mean solar times, there are other special time scales appropriate to the other tides.

The process of reduction consists of the determination of the mean height of the water at each of twenty-four special hours, and subsequent harmonic analysis. The means are taken over such periods of time that the influence of all the tides governed by other special times is eliminated.

The process by which the special hourly heights have hitherto been obtained is the entry of the heights observed at the mean solar hours in a schedule so arranged that each entry falls into a column appropriate to the nearest special hour. Schedules of this kind were prepared by Mr. Roberts for the Indian Government.[1] The successive rearrangements for each sort of special time were made by recopying the whole of the observations time after time into a series of appropriate schedules. The mere clerical labour of this work is enormous, and great care is required to avoid mistakes.

All this copying might be avoided if the observed heights were written on movable pieces. But a year of observation gives 8760 hourly heights, and the orderly sorting and resorting of nearly 9000 pieces of paper or tablets might prove more laborious and more treacherous than recopying the figures.

The marshalling of movable pieces might, however, be reduced to manageable limits if all the twenty-four observations pertaining to a single mean solar day were moved together, for the movable pieces would be at once reduced to 365, and each piece might be of a size convenient to handle.

The realization of this plan affords the subject of this paper, and it appears that not only is all desirable accuracy attainable, but that the other requisite of such a scheme is satisfied, namely, that the whole computing apparatus shall serve any number of times and for any number of places.

The first idea which naturally occurred was to have narrow sliding tablets which should be thrown into their places by a number of templates. It is unnecessary to recount all the trials and failures, but it will suffice to say that the slides and templates would require the precision of a mathematical instrument if they are to work satisfactorily, and that the manufacture would be so expensive as to make the price of the instrument prohibitive.

The idea of making the tablets or strips to slide into their places was accordingly abandoned, and the strips are made with short pins on their under sides, so that they can be stuck on to a drawing board in any desired position. The templates, which were also troublesome to make, are replaced by large sheets of paper with numbered marks on them to show how the strips are to be set. The guide sheet is laid on a drawing board, and the pins on the strips pierce the paper and fix them in their proper positions.

The strip belonging to each mean solar day is divided by black lines into 24 equal spaces, intended for the entry of the hourly heights of water. The strip is nine inches long by $\frac{1}{4}$ inch wide, and the divisions ($\frac{3}{8}$ by $\frac{1}{4}$) are of convenient size for the entries. There was much difficulty in discovering a good material, but after various trials artificial ivory, or xylonite, was found to serve the purpose. Xylonite is white, will take writing with Indian ink or pencil, and can easily be cleaned with a damp cloth. It is just as easy to write with liquid Indian ink as with ordinary ink, which must not be used, because it stains the surface.

The observations are to be treated in groups of two and a half lunations or 74 days. A set of strips, therefore, consists of 74, numbered from 0 to 73 in small figures on their flat ends.

If a set be pinned horizontally on a drawing board in vertical column, we have a form consisting of rows for each mean solar day, and columns for each hour. The observed heights of the water are then written on the strips.

When the twenty-four columns are summed and divided by the number of entries we obtain the mean solar hourly mean heights. The harmonic analysis of these means gives the mean solar tides. But for evaluating the other tides the strips must be rearranged, and to this point we turn our attention.

Let us consider a special case, that of mean lunar time. A mean lunar hour is about 1h. 2m. m.s. time; hence the 12h. of each m.s. day must lie within 31m. m.s. time of a mean lunar

[1] "On an Apparatus for facilitating the Reduction of Tidal Observations." By G. H. Darwin, F.R.S., Plumian Professor and Fellow of Trinity College, Cambridge. A paper read before the Royal Society on December 15, 1892.

[1] An edition of these computation forms was reprinted by aid of a grant from the Royal Society, and is sold by the Cambridge Scientific Instrument Company, but only about a dozen copies now remain.

hour. The following sample gives the incidence to the nearest lunar hour of the first few days in a year:—

Mean solar time. d.	h.		Mean lunar time. d.	h.
0	12	=	0	12
1	12	=	1	11
2	12	=	2	10
3	12	=	3	9
4	12	=	4	8
5	12	=	5	8
6	12	=	6	7
7	12	=	7	6
&c.			&c.	

The successive 12h. of m.s. time will march retrogressively through all the twenty-four hours of m. lunar time.

Now, if starting from strip 0, we push strip 1 one division to the left, strip 2 two divisions to the left, and so on, the entries on the strips will be arranged in columns of approximately lunar time.

The rule for this arrangement is given by marks on a sheet of paper 18 in. broad; these marks consist of parallel numbered steps or zigzags showing where the ends of each strip are to be placed so as to bring the hourly values into their proper places.

At the end of a lunation mean solar time has gained a whole day over mean lunar time, and the 12h. solar again agrees with the 12h. lunar. On the guide sheet the zigzag which takes its origin at the left end of strip 0 has descended diagonally from right to left until it has reached the left margin of the paper, and a new zigzag has begun on the right margin.

When the strips are pinned out following the zigzags on the sheet marked M, the entries are arranged in 48 columns, but the number of entries in each column is different. The 48 incomplete columns may be regarded as 24 complete ones, appertaining to the 24 hours.

Harmonic analysis of the 24 means of the complete columns gives the required tidal constants. It must be remarked, however, that as the incidence of the entries is not exact in lunar time, investigation is made in the paper of the corrections arising out of this inexactness.

The explanation of the guide sheet for lunar time will serve, *mutatis mutandis*, for all the others.

The zigzags have to be placed so as to bring the columns into exact alignment, and printers' types provide all the accuracy requisite.

To guard against the risk of the computer accidentally using the wrong sheet, the sheets are printed on coloured paper, the sequence of colours being that of the rainbow. The sheets for days 0 to 73 are all red; those for days 74 to 74 + 73, or 147, are all yellow; those for days 148 to 148 + 73, or 221, are green; those for days 222 to 222 + 73, or 295, are blue; and those for days 296 to 296 + 73, or 369, are violet.

Thus, when the observations for the first 74 days of the year are written on the strips all the sheets will be red; the strips will then be cleaned, and the observations for the second 74 days written in, when all the guide sheets will be yellow, and so on.

The paper also gives another considerable abridgement of the process of harmonic analysis, which is independent of the method of arrangement just sketched.

In the Indian computation forms the mean solar hourly heights have been found for the whole year, and the observations have been rearranged for the evaluation of certain other tides governed by a time scale which differs but little from the mean solar scale. It is now proposed to break the mean solar heights into sets of 30 days, and to analyse them, and next to harmonically analyse the 12 sets of harmonic constituents for annual and semi-annual inequalities. By this plan the harmonic constants for 11 different tides are obtained by one set of additions. In fact, we now get the annual, semi annual, and solar elliptic tides, which formerly demanded much troublesome extra computation. A great saving is secured by this alone, and the results are in close agreement with those derived from the old method.

An abridged method of evaluating the tides of long period MSf, Mf, Mm, is also given. The method is less accurate than that followed hitherto, but it appears to give fairly good results, and reduces the work to very small dimensions.

The advantages of the method proposed in the present paper may be best realized by a comparison of the amount of work entailed in the reduction of a year's tides as it has hitherto been carried out by the Indian Survey at Poona, and what it will be under the new method.

It has been usual in the Indian reductions to use three digits in expressing the height of water, and there have been fifteen series, or even more. It follows from a simple multiplication that the computer has had to write 394,000 figures in reducing a year of observation. This does not include the evaluation of the annual and semi-annual tides, so that we may say that there have been about 400,000 figures to write.

It is now proposed to express the heights by two digits, and they only have to be written once, and the number of figures to write is 17,500; accordingly the writing of 382,000 figures is saved.

In the old method the computer had to add together all the digits written, say, 394,000 additions of digit to digit.

It is now proposed to use twenty-four hourly values in three series, viz. S, M, and MS, and twelve two-hourly values in eight others, and the number of additions comes to 123,000. Thus 270,000 additions are saved.

We may say that formerly there were about 800,000 operations (writing and addition), and that in the present method there will be about 140,000. This estimate does not include a saving of several thousands of operations in obtaining the tides of long period. It may therefore be claimed that the work formerly bestowed on one year of observation will now reduce at least five years, and that the results are equally trustworthy.

The manufacture of the computing strips of xylonite is rather expensive, but as it formerly cost in England rather more than £20 to reduce a year of observation, the cost of the apparatus will be covered by the saving in the reduction of a single year, and it will serve for any length of time.

The apparatus, together with computation forms, will be on sale with the Cambridge Scientific Instrument Company at a price of about £8.

It is proper to mention that Dr. Börgen has devised and used a method for attaining the same end as that aimed at in this paper. He has prepared sheets of tracing paper with diagonal lines on them, so arranged that when any sheet is laid on the copy of the observations written in daily rows and hourly columns, the numbers to be summed are found written between a pair of lines. This plan is inexpensive and has considerable advantages, but the chance of error is no doubt increased by the fact that the lines of addition are diagonal, and because figures seen through tracing-paper are comparatively faint.

THE HARVARD COLLEGE OBSERVATORY.

THE forty-seventh annual report of the director of the astronomical observatory of Harvard College, for the year ending October 31, 1892, by Prof. E. C. Pickering, has been issued. We reprint the following passages:—

The number of photographs taken with the eight-inch Draper telescope is 2777. The number taken in Peru with the Bache telescope is nearly two thousand, of which 601 have been received in Cambridge. The examination of these plates has as usual led to the discovery of a large number of interesting objects. Ten variable stars, U Delphini, S Pegasi, T Aquarii, R Crateris, R Carinæ, S Canis Minoris, S Carinæ, R Ophiuchi, X Ophiuchi, and Espin's variable star in Auriga in addition to the thirty-seven previously announced have the hydrogen lines bright in their spectra. Seven new variable stars have been discovered this year by means of this property. The number of stars of the fifth type has been increased by eight, making the total number now known of these objects forty-five. The hydrogen line F was shown to be bright in the spectra of six stars in addition to those already known. Photographs have been obtained of the spectra of eight planetary nebulæ showing bright lines. The spectrum of the nebula surrounding thirty Doradus is unlike that of other gaseous nebulæ. The star A. G. C. 20,937 has a somewhat similar spectrum. Five stars have been shown to have spectra of the fourth type. All of these peculiarities have been detected by Mrs. Fleming except in the cases of one of the known variables, one of the planetary nebulæ, and two of the stars of the fourth type, which were found by Mr. A. E. Douglass, in Peru, before the plates were sent to Cambridge.

The amount of valuable material accumulated with these instruments is continually increasing, and has proved useful in many cases in studying the history of newly-discovered objects.

The brightness for several years past of stars suspected of variability has been furnished to various astronomers. Plates have been sent to the Lick and Amherst Observatories and to the Smithsonian Institution for special investigations. From one of them a new variable star in Aries was discovered by Prof. Schaeberle. It is hoped that this use of our plates may increase in the future. A large number of photographs were taken of the new star in Auriga. An examination of the older photographs showed that the region containing it had been photographed eighteen times from November 3, 1885, to November 2, 1891, and that it was then apparently fainter than the thirteenth magnitude. It appeared upon five plates taken between December 16, 1891, and January 31, 1892. After its discovery it was photographed on sixty-five chart plates and thirty-six spectrum plates, until April 6, when it became too faint to be visible in the encroaching twilight. All of these plates have been carefully studied and measured. Twenty-one charts and fifteen spectrum plates of this object have been taken since its reappearance in September, 1892. On these last plates, the spectrum is shown to resemble that of a planetary nebula.

Many photographs of the lunar eclipse of November 15, 1891, were taken both at Cambridge and at the Boyden observing station near Arequipa, Peru. The examination of these photographs for the detection of a possible lunar satellite led only to a negative result.

The number of photographs taken with the 11-inch Draper telescope is 996. They include 372 spectra of β Aurigæ to determine the law of periodic doubling of the lines. 244 of these images show the lines double so that the separation can be measured. In like manner 208 spectra of ζ Ursæ Majoris have been photographed, and in 49 of them the lines are separated widely enough to be measured. A similar study has been made of the new star in Auriga, of β Lyræ, of 11 Monocerotis, and of some other stars having peculiar spectra. Photographic charts have also been obtained of numerous variable stars, stars having large proper motion, clusters and stars having peculiar spectra to determine their parallax if it is perceptible.

Boyden Department.

In establishing the fund that bears his name, Mr. Boyden desired to secure an astronomical station where the effects due to the atmosphere would be greatly diminished. This has now been successfully accomplished in the Harvard Station at Arequipa, Peru, where the effect of the air is no longer as heretofore the principal obstacle to progress in astronomy. Instead of this the limit is now the size and excellence of our instruments. A great advance would probably be made in our knowledge of the planets, and perhaps of the fixed stars, if a telescope of the largest size could be mounted under such favourable conditions.

This station has continued in charge of Prof. W. H. Pickering. The instruments chiefly employed have been the 13-inch telescope, the 8-inch Bache telescope, and a photographic camera having an aperture of 2½ inches. The first of these instruments has been largely devoted to visual work, for which unusual advantages are afforded by the transparency and steadiness of the air at this station. Many interesting results have been derived from the observations made of the moon and various planets. The observations of the moon relate to Plato and other regions, which have been carefully examined, and also to the systems of bright streaks visible at full moon. The markings of Mercury have been studied, and this investigation appears to confirm Schiaparelli's view that the rotation of Mercury on its axis occupies the same time as its revolution in its orbit. Although this planet appears to have no atmosphere, the markings upon it are very faint compared with those upon the moon. Venus was micrometrically studied near its inferior conjunction with regard to its diameter, polar compression, and the refractive effect of its atmosphere. No permanent markings could be detected. An extensive series of observations was made upon Mars. The relative positions of 92 points upon its surface were determined by the micrometer. More than forty minute black points were discovered, provisionally designated as lakes. The polar compression of the planet was measured, and appeared to be greater than that indicated by theory, which may be due to an excess of cloud in the equatorial regions. The presence of the dark and narrow streaks called canals by Schiaparelli has been confirmed and various measurements of them have been made. The clouds projecting beyond the limb, and terminator, discovered at the Lick Observatory, have been studied, and their height has been found to be at least twenty miles. The relative colours of different portions of the planet have been minutely observed. Two large dark blue areas have been detected, and other portions have been noticed to be subject to gradual changes of colour.

Many new double stars were found in a survey of the heavens south of 30°, between 12h. and 18h. The August occultation of Jupiter was observed both visually and photographically, as was also the new star in Auriga and Swift's comet, the photographs of which showed detail not noticeable in the visual observations.

With the camera, having the aperture 2½ inches, very satisfactory photographs have been obtained of the Magellanic clouds, showing their composition to be partly of stars and partly of nebulous matter; also the spiral structure of the larger of the two clouds.

Meteorological observations are regularly carried on. Stations have been established at Mollendo, 100 feet above sea level, at La Joya, the elevation of which is 4,150 feet, at the observing station, 8,060 feet high, at the Chachani Ravine 16,650 feet high, where numerous miscellaneous observations have been made. Notwithstanding the great height of the last-named station, it can be reached by a mule path, and a hut has been erected where the observers can pass the night. A survey of the Arequipa valley and neighbouring mountains has been made, depending on two separate base lines. The heights of the mountains have been measured, and in some cases the result has been checked by a mercurial barometer.

The Bruce Photographic Telescope.

This instrument, which if successful will be in many respects the most powerful in the world, is now rapidly approaching completion. The eight surfaces of its objective have been ground and polished so that it could be tested on a star. The results were satisfactory, although, of course, no definite opinion can be formed until the final corrections are applied. The focal length proved to be that desired within half of one per cent. Plans have been made and the foundations laid for a one-story brick building with a sliding roof, in which it will be erected during its trial in Cambridge. After this it is proposed to send it to the Arequipa station in Peru.

Photographs have been taken with the transit photometer on 192 evenings, and when clear, throughout the entire night. With this instrument images are obtained of all stars brighter than the sixth magnitude which cross the meridian during the night. The value of this work was illustrated when the new star in Auriga was discovered in February, 1892. It then appeared that this object had been photographed on twelve nights since December 10, 1891, while no trace of it was visible on thirteen plates covering this region and taken before December 2, 1891. The only knowledge that exists of its changes of light during the six weeks in which it remained undiscovered is furnished by these photographs and those taken with the 8-inch telescopes. It was also photographed with the transit photometer on twelve nights after its discovery. Of the forty thousand standard stars of the tenth magnitude about eight thousand have been selected by Miss E. F. Leland during the past year, making eleven thousand in all.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Oxford.—In the Chemical Department Prof. Odling is lecturing on the glucoses, Mr. Fisher on inorganic chemistry, Dr. Watts on organic chemistry, and Mr. Veley on physical chemistry. There are about sixty students working in the laboratories, and a few of the senior men are engaged in research.

Among the apparatus belonging to the late Duke of Marlborough, presented by the Duchess, are three large spectroscopes by Hilger, one having five prisms, another being a direct vision spectroscope 5 feet 6 inches in length, two balances by Deleuil; a mercury pump by Alvergniat, Dumas' vapour density apparatus, Thomson's electrometer gramme machine, large Rhumkorf coil and a quantity of valuable glass apparatus. There are besides a number of specimens of compounds of rare earths.

The Regius Professor of Medicine has placed his pathological

laboratory under the direction of the lecturer in Pharmacology. Dr. Ritchie of Edinburgh is carrying out in it some researches in Bacteriology. The Chemical Club started last term by some of the senior men continues to hold meetings weekly for the discussion of recent chemical investigations. Mr. Ingham of Merton is secretary. The meetings are well attended and useful.

Mr. R. T. Günther, B.A., Demy of Magdalen College, has been elected to the Naples Biological Scholarship for the ensuing year.

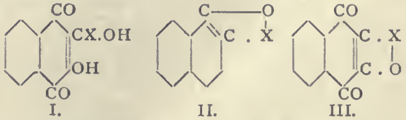
CAMBRIDGE.—Mr. H. Bury, Fellow of Trinity College, has been appointed by the Board for Biology and Geology to the use of a table at the Naples Zoological Station for March and April, 1893.

The Boards for Biology and Geology, and for Physics and Chemistry, have reported in favour of extending to Part I. of the Natural Sciences Tripos the plan already adopted for Part II., namely, the substitution of distinct papers in each scientific subject, instead of papers each of which contains questions in all the subjects. They propose that the change come into operation in 1894.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, January 19.—Prof. A. Crum-Brown, President, in the chair.—The following papers were read:—Glucinum, Part I. The preparation of glucina from beryl, by J. Gibson. The methods at present in use for preparing pure glucina from beryl are tedious and difficult to apply on the large scale, as the mineral, which contains but a small quantity of glucinum, has to be reduced to a very fine powder before being treated by the reagents usually employed for the decomposition of refractory silicates. The author has worked out a process which greatly facilitates the preparation of glucina. If the coarsely-ground beryl is heated in an iron vessel with six parts of ammonium hydrogen fluoride, complete decomposition occurs below a red heat. The product contains the aluminium and most of the iron as insoluble fluoride and oxide respectively, together with glucinum fluoride, which dissolves on extraction with water. In order to remove the last traces of iron from crude glucina, advantage is taken of the fact that the precipitation of a lead or mercuric salt by ammonium sulphide effects by mass action the complete separation of small quantities of iron which may be present in the solution.—The determination of the thermal expansion of liquids, by T. E. Thorpe. The author describes various improvements in the ordinary dilatometrical method of determining the thermal expansion of liquids. Amongst these the most important is the application of a device frequently employed in the construction of standard thermometers, and consisting in enlarging the bore of the dilatometer stem at some point. On such an instrument the positions of the 0° and 100° points may be determined irrespectively of its range, and the thermometer, and the column of liquid in the dilatometer stem may be totally immersed in a bath of moderate size, thus doing away with corrections for the emergent columns of the two instruments. The methods of constructing, calibrating, and using the dilatometers are described, together with the baths employed in heating them.—The determination of the thermal expansion and specific volume of certain paraffins and paraffin derivatives, by T. E. Thorpe and L. M. Jones. The authors give the data relating to a number of hydrocarbons, alcohols, ketones, and other derivatives of the paraffins. The results show a fairly satisfactory agreement, in most cases, with the values calculated by Lossen's formula, but all the observed specific volumes, with the exception of that of propionic anhydride, differ considerably from those calculated by means of Kopp's values.—The hydrocarbons derived from dipentene dihydrochloride, by W. A. Tilden and S. Williamson. The dihydrochloride, $C_{10}H_{16}2HCl$ melting at 50°, prepared by the action of moist hydrogen chloride on optically active turpentine, is known to be identical with that obtained from the active citrenes (limonenes) or from inactive "dipentene." On heating it with aniline, an oil is obtained which has hitherto been supposed to consist essentially of dipentene; on oxidising it, however, a certain proportion of aromatic acids is obtained. These acids are not formed on oxidising the active limonenes or pure dipentene with nitric acid; their formation in the previous case is, however, satisfactorily explained by the authors, who find that the dipentene obtained from the dihydrochloride contains large proportions of cymene, terpinene, terpinolene, and a small quantity of a saturated paraffinoid hydrocarbon boiling at about 155°.—Sulphonic derivatives of camphor, by F. S. Kipping and W. J. Pope. The authors have succeeded in preparing camphorsulphonic acid, $C_{10}H_{15}O.SO_3H$, a compound hitherto unknown, by the direct action of anhydrosulphuric acid or chlorosulphonic acid on camphor. The acid is purified by the conversion of its sodium salt into camphorsulphonic chloride, $C_{10}H_{15}O.SO_2Cl$; the latter substance is apparently obtained in optically different modifications which are separated only with considerable difficulty. The sulphonic chloride is readily hydrolysed on boiling with water, yielding the sulphonic acid from which a series of well-defined salts has been obtained. The action of anhydrosulphuric acid on bromocamphor results in the formation of bromocamphorsulphonic acid; this on suitable treatment yields a sulphonic chloride, $C_{10}H_{14}BrO.SO_2Cl$, which crystallises in magnificent colourless octahedra, melting at 136–137°. A bromocamphorsulphonic chloride of similar composition has been previously described by Marsh and Cousins as a "black, semi-crystalline tar;" a repetition of their work shows this to be merely an impure form of the substance now described. The corresponding chlorocamphorsulphonic chloride described by Marsh and Cousins as a "microcrystalline, black solid," crystallises in massive colourless octahedra when pure; it melts at 123–124°, and has a specific rotatory power $[\alpha]_D = +110°$. The authors describe a number of salts and derivatives of these sulphonic acids.—The preparation of dinitro-α-naphthylamine $[NH_2 : NO_2 : NO_2 = 1 : 2 : 4]$ from its acetyl and valeryl derivatives, by R. Meldola and M. O. Forster. Meldola's process of preparing dinitro-α-naphthylamine from α-acetnaphthalide having been questioned, the authors have re-investigated the method and confirm it in all respects; they give full working details of the process, and show that the same product is obtained by the nitration and subsequent hydrolysis of valeronaphthalide.—Thionyl bromide, by J. Hartog and W. E. Sims. Thionyl bromide is obtained as a heavy, crimson liquid by the action of sodium bromide on thionyl chloride; its colour is possibly due to impurity. At 150° the bromide decomposes, yielding bromine and sulphur bromides.—Desulphurisation of the substituted thioureas, by A. E. Dixon. The monosubstituted thioureas are all desulphurised on boiling with an alkaline solution of a lead salt; the same is true of disubstituted thioureas containing benzenoid groups, but not if such groups be absent. The tri- and probably also the tetra-substituted thioureas are not desulphurised under similar conditions. A number of new thioureas are described.—Salts of active and inactive glyceric acid: the influence of metals on the specific rotatory power of active acids, by P. F. Frankland and J. R. Appleyard. The authors have prepared and analysed a number of salts both of inactive and dextro-glyceric acid; the solubilities and specific rotatory powers are also given. Certain remarkable numerical relations apparently exist between the rotations of many of the salts; these should have considerable bearing on the vexed question of multiple rotation, and will be discussed after they have been submitted to a more detailed investigation.—Dibromo-β-lapachone, by S. C. Hooker and A. D. Gray. Monobromo-β-lapachone cannot be converted into dibromo-β-lapachone by the action of bromine alone; the formation of the latter derivative in the preparation of monobromo-β-lapachone from lapachol, is due to the production and subsequent decomposition of an additive compound of monobromo-derivative and hydrogen bromide.—The conversion of para- into ortho-quinone derivatives, by S. C. Hooker. Both in the lapachol and other groups, compounds derived from α-naphthaquinone, of the type represented by formula I., are far more readily converted, by the action of acids, into anhydrides derived from β-naphthaquinone (II.) than into anhydrides of the α-quinone type (III.).

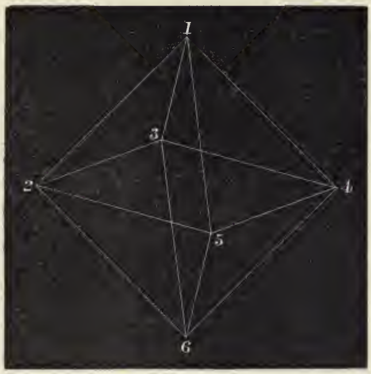


I. II. III.

—The nitro-derivatives of phenolphthalein, by J. A. Hall. The author has prepared dinitro- and tetranitro-phenolphthalein,

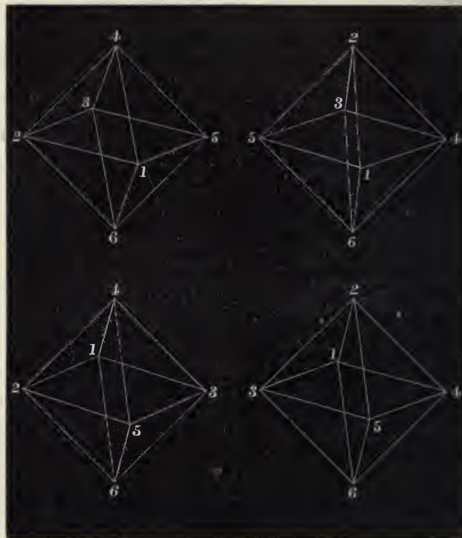
and describes their properties.—A method for the preparation of acetylene, by M. W. Travers. Calcium carbide may be prepared by heating a mixture of sodium, gas carbon, and calcium chloride for half an hour at bright redness in an iron bottle. The carbide thus obtained yields acetylene on treatment with water. 240 c.c., half the theoretical quantity, of acetylene is obtained for every gram of sodium used in the preparation of the carbide.

Mathematical Society, February 9.—Mr. A. B. Kempe, F.R.S., President, in the chair.—The following communications were made:—The Harmonics of a Ring, by Mr. W. D. Niven, F.R.S. This paper treats of the potential functions of an anchor ring, and explains how problems to which those functions are applicable may be solved for two coaxal rings. The proposition on which the method depends establishes that the ring harmonics of any degree may be derived from their predecessors of lower degree by simple differentiations with regard to the radius of the dipolar circle of the ring and the distance of a fixed point from the plane of this circle. Ultimately the harmonics depend upon the potential at any point due to a distribution on the circle either uniform or varying as a circular function of the arc. Now the potential due to such distribution on a circle B may readily be expressed in terms of the harmonics pertaining to a coaxal circle A, and hence any harmonic pertaining to B, and therefore any series of such harmonics, may be expressed in a series pertaining to A. In the latter form they are suitable for the application of surface conditions at any ring whose dipolar circle is A. The application worked out in the paper is the problem of the influence of two electrically charged coaxal rings upon one another. It is also shown how the same problem may be solved for a ring and sphere, symmetrically situated as regards the axis.—The group of thirty cubes composed by six differently coloured squares, by Major MacMahon, R.A., F.R.S. Selecting any one of the thirty cubes at pleasure it is possible to select eight of the remaining twenty-nine which in reference to the cube selected have a very peculiar and interesting



Selected Cube (transformed) diagonal 16 vertica

property. It is possible to form the eight cubes into a single cube in such wise that contiguous faces of the cubes are similarly coloured, and also so that the resulting cube has the appearance of the *selected* cube in regard to the colouring of its faces. To each cube of the thirty belong in this way eight other cubes, the selection of the eight cubes being unique. For the examination of this property the selected cube is transformed into an octahedron by joining the middle point of each face to the middle points of the adjacent faces; a regular octahedron with six differently coloured summits is thus obtained. Each triangular face is determined by three differently coloured summits, and exactly eight other octahedra are obtained by circular substitutions performed on the three colours which determine a face; in regard to the eight faces there are eight clock-wise and eight counter clock-wise substitutions, but only eight different octahedra can be obtained. These give the eight cubes associated with the selected cube. The eight cubes having been determined, the problem of forming them admits of just two solutions. One solution is—



Lower Four Cubes.

Upper Four Cubes.

The other solution is obtained by interchanging clock-wise and counter clock-wise rotations of octahedral faces. Other interesting properties of these cubes are examined in the paper.

Geological Society, January 25.—W. H. Hudleston, F.R.S., President, in the chair.—The following communications were read: On inclusions of tertiary granite in the Gabbro of the Cuilin Hills, Skye; and on the products resulting from the partial fusion of the acid by the basic rock, by Prof. J. W. Judd, F.R.S.—Anthracite and bituminous coal-beds; an attempt to throw some light upon the manner in which anthracite was formed; or contributions towards the controversy regarding the formation of anthracite, by W. S. Gresley.

February 8.—W. H. Hudleston, F.R.S., President, in the chair.—The following communnications were read: Notes on some coast-sections at the Lizard. By Howard Fox and J. J. H. Teall, F.R.S. In the first part of the paper the authors describe a small portion of the west coast near Ogo Dour, where hornblende-schist and serpentine are exposed. As a result of the detailed mapping of the sloping face of the cliff, coupled with a microscopic examination of the rocks, they have arrived at the conclusion that the serpentine is part and parcel of the foliated series to which the hornblende-schists belong, and that the apparent evidences of intrusion of serpentine into schist in that district are consequences of the folding and faulting to which the rocks have been subjected since the banding was produced. The interlamination of serpentine and schist is described, and also the effects of folding and faulting. Basic dykes, cutting both serpentine and schists, are clearly represented in the portion of the coast which has been mapped, and these locally pass into hornblende-schists, which can, however, be clearly distinguished from the schists of the country. The origin of the foliation in the dykes is discussed. The second part of the paper deals with a small portion of the coast east of the Lion Rock, Kynance. Here a small portion of the "granulitic series" is seen in juxtaposition with serpentine. The phenomena appear to indicate that the granulitic complex was intruded into the serpentine; but they may possibly be due to the fact that the two sets of rocks have been folded together while the granulitic complex was in a plastic condition, or to the intrusion of the serpentine into the complex while the latter was plastic.—On a radiolarian chert from Mullion Island, by Howard Fox and J. J. H. Teall. The main mass of Mullion Island is composed of a fine-grained "greenstone," which shows a peculiar globular or ellipsoidal structure, due to the presence of numerous curvilinear joints. Flat surfaces of this rock, such as are exposed in many places at the base of the cliff, remind one somewhat of the appearance of a lava of the "pahoehoe" type. The stratified rocks, which form only a very small portion of the island, consist of cherts, shales, and limestone. They occur as thin strips or sheets, and sometimes as detached lenticles within the igneous mass. The chert occurs in bands varying from a quarter of an inch to several inches in thickness, and is of radiolarian origin. The radiolaria are often clearly recognisable on the weathered surfaces of some of the beads, and the reticulated nature of the test may be observed by simply placing a portion of the weathered surface under the microscope. The authors describe the relations between the sedimentary and igneous rocks, and suggest that the peculiar phenomena may be due either to the injection of igneous material between the layers of the stratified series near the surface of the sea-bed while deposition was going on, or possibly to the flow of a submarine lava. The form of the radiolaria observed in the deposit, and also their mode of preservation, are described in an appendix by Dr. G. J. Hinde.—The reading of these papers was followed by a discussion, in which the President, Rev. Edwin Hill, Prof. Bonney, Dr. Hicks, Dr. Hind, and the authors took part.—Note on a radiolarian rock from Fanny Bay, Port Darwin, Australia, by G. J. Hinde. A specimen brought from Fanny Bay by Captain Moore, of H.M.S. *Penguin*, is of a dull white or yellowish tint, in places stained red. It has an earthy aspect, and is somewhat harder than chalk, but gives no action with hydrochloric acid. Microscopic sections show a fairly transparent groundmass, apparently amorphous silica, containing granules and subangular fragments up to ·075 millim. in diameter, some of which appear to be quartz. Besides this, the rock contains numerous radiolaria, and it is really a radiolarian earth intermediate in character between the Barbados earth and such cherts as those of the Ordovician strata of Southern Scotland. The details of the extent of the deposit and its relationship to other rocks of the area are not yet obtainable, though it is possible that a considerable thickness of rock mentioned by Mr. Tenison Woods as occurring in this area may also be of radiolarian origin. The author describes a species of *Cenellipsis*, two of *Astrophacus*, one of *Lithocyclia* (new), one of *Amphibrachium*, three of *Spongodiscus* (one new), four of *Spongolena* (all new), two of *Dictyomitra* (both new), one of *Lithocampe* (new), and two of *Stichocapsa* (both new). From these it is not practicable at present to determine the geological horizon of the rock; with one exception, all the genera represented occur from Palæozoic times to the present.—Notes on the geology of the district west of Caermarthen. Compiled from the notes of the late T. Roberts (communicated by Prof. T. McKenny Hughes, F.R.S.). To the east of the district around Haverfordwest, formerly described by the author and another, an anticlinal is found extending towards Caermarthen. The lowest beds discovered in this anticline are the *Tetragraptus*-beds of Arenig age, which have not hitherto been detected south of the St. David's area. They have yielded eight forms of graptolite, which have been determined by Prof. Lapworth. The higher beds correspond with those previously noticed in the district to the west; they are, in ascending order: (1) Beds with "tuning-fork" *Didymograpti*, (2) Llandeilo limestone, (3) *Dicranograptus*-shales, (4) Robeston Wathen and Sholeshook limestones. Details of the geographical distribution of these and of their lithological and palæontological characters are given in the paper. After the reading of this paper Dr. Hicks said he felt sure he was expressing the feelings of the Fellows in referring to the serious loss which the Society had suffered by the death of Mr. T. Roberts, who certainly was one of the most promising palæontologists in this country. The important researches which he carried on, in conjunction with Mr. Marr, had made is now comparatively easy to understand some intricate and extensive districts in Pembrokeshire and Caermarthenshire, which previously were little more than blanks on the geological map.

February 17.—Anniversary Meeting.—The medals and funds were awarded as follows:—The Wollaston medal to Prof. N. S. Maskelyne, F.R.S.; Murchison medal to the Rev. O. Fisher; Lyell medal to Mr. E. T. Newton; and the Bigsby medal to Prof. W. J. Sollas, F.R.S.; the balance of the proceeds of the Wollaston fund to Mr. J. G. Goodchild; that of the Murchison fund to Mr. G. J. Williams; and that of the Lyell fund to Miss C. A. Raisin and Mr. A. N. Leeds. The following is the list of officers and council elected at the meeting:—President: W. H. Hudleston, F.R.S. Vice-Presidents: Sir A. Geikie, F.R.S., G. J. Hinde, Prof. J. W. Judd, F.R.S., H. Woodward, F.R.S. Secretaries: J. E. Marr, F.R.S., J. J. H. Teall, F.R.S. Foreign Secretary: J. W. Hulke, F.R.S. Treasurer: Prof. T. Wiltshire. Prof. J. F. Blake, Prof. T. G. Bonney, F.R.S., R. Etheridge, F.R.S., Sir A. Geikie, F.R.S., Prof. A. H. Green, F.R.S., Alfred Harker, H. Hicks, F.R.S., G. J. Hinde, T. V. Holmes, W. H. Hudleston, F.R.S., J. W. Hulke, F.R.S., Prof. J. W. Judd, F.R.S., R. Lydekker, Lieut.-General C. A. McMahon, J. E. Marr, F.R.S., H. W. Monckton, Clement Reid, F. Rutley, J. J. H. Teall, F.R.S., Prof. T. Wiltshire, Rev. H. H. Winwood, H. Woodward, F.R.S., H. B. Woodward. The presidential address dealt with some recent work of the Geological Society, the subjects ranging over a period of six or seven years. These embraced Pleistocene geology, theories in connection with Glaciation, Tertiary, Cretaceous, Jurassic, and Permo-Triassic geology. It further mentions that the number of papers on Pleistocene geology has been very considerable, and many of them relate to the south-east and the south of England; those relating to Central England and South Wales were fewer in number, whilst the north had furnished but few papers. The great memoir on the Westleton Beds had provided much material for consideration; that portion relating to the Southern Drift being especially interesting. Reference was made to a paper on Pleistocene succession in the Trent basin as forming a fitting introduction to the fascinating problems connected with the North Wales border on the one side and with Flamborough Head on the other. From Scotland notice was taken of some supplementary remarks on the paralled roads of Glen Roy. Speculation as to the evidence of a palæozoic ice age, the date and duration of the Pleistocene glacial period, and a notice on misconceptions regarding the evidence of former glacial periods were also discussed. The Tertiary Geology of the London and Hampshire basins was considered, more especially in relation to the Upper Eocene, or Bartons, and their probable equivalents in West Surrey. Under this heading, also, comes the Geology of Barbados, since the oceanic deposits in that island were held to be of late Tertiary age. These interesting discoveries were reviewed

at some length, and the results compared with tables in the recently issued "*Challenger* Reports." In Upper Cretaceous Geology the phosphatic deposits at Ciply and Taplow were noticed, and also the important correlations of the basement-beds in Norfolk, Lincolnshire, and East Yorkshire. The Lower Cretaceous beds at Speeton next passed under review, more especially in connection with their somewhat difficult palæontology and possible equivalents in Eastern Europe. It then went on to state that our knowledge of the Upper Jurassics of the East of England had of late years received considerable additions and important correlations between our Upper Jurassics generally, and their equivalent on the Jura had been effected, that the inferior Oolite and the Lias boundary had come in for their share of attention, whilst a determined attempt had been made to refer a portion of the red rocks of South Devon to the Permian.

Paris.

Academy of Sciences, February 13.—M. de Lacaze-Duthiers in the chair.—On an invariant number in the theory of algebraic surfaces, by M. Émile Picard.—Study of the Cañon Diablo meteorite, by M. Henri Moissan. The composition of the meteorite is very variable from point to point. In the fragments examined the percentage of iron varied from 91·09 to 95·06, and that of nickel from 1·08 to 7·05. Diamonds were also found, both transparent and black, and a brown form of carbon of feeble density. The largest diamond measured 0·7 mm. by 0·3 mm. It had a yellow tint and a rough surface, and was transparent to light.—On the meteoric iron of Cañon Diablo, by M. C. Friedel. A small quantity of a silver-white fragile compound occurring in the meteorite in the form of plates disseminated through the nickeliferous iron and accompanied by schreibersite, was isolated, and its composition found to correspond to the probable formula Fe_5S. The mixtures of ordinary carbon, graphite, and diamond were found chiefly associated with nodules of yellow troilite.—On the presence of graphite, carbonado, and microscopic diamonds in the blue earth of the Cape, by M. Henri Moissan. After repeated and lengthy treatment with boiling sulphuric and hydrofluoric acids, 250 gr. of blue earth left a residue weighing only 0·094 mgr. In this residue brilliant hexagonal crystals of graphite were found, giving rise, when treated with potassium chlorate, to a graphitic oxide of a colour passing from green to yellow. Another species of graphite was also isolated which, when treated with H_2SO_4 at 200° C., swelled up considerably and dissolved. Its artificial preparation will be described in a subsequent paper. The portions of the residue unaffected by potassium chlorate and heavier than methylene iodide (density 3·4) comprised an amber-coloured mass, black diamonds, microscopic true diamonds, and small transparent crystals in form of elongated prisms, which did not burn in oxygen and were not fluorescent in violet light. The first, which contains a large proportion of iron, and the last, which contains silica, can be destroyed by treatment with fused potassium bisulphate and then with hydrofluoric and sulphuric acids. The blue earth, which was taken from the Old de Beers Mine, thus contained all the carbon compounds found in the iron matrix employed for their artificial production.—The clasmatocytes, the fixed cellules of the connective tissue, and the pus globules, by M. L. Ranvier. In an inflamed tissue the clasmatocytes and leucocytes are the only ones which give rise to purulent globules, the latter being, in fact, mortified lymphatic cellules.—Glycosic expenditure attendant upon nutritive movement in hyperglycemia and hypoglycemia brought about experimentally; consequences bearing upon the immediate cause of diabetes and other deviations of glycemic function, by MM. A. Chauveau and Kaufmann.—Observations of Holmes's comet made with the *equatorial coudé* (0·32 m.) of the Lyon Observatory, by M. G. Le Cadet.—On an explicit form of the addition formulæ of the most general hyperelliptic functions, by M. F. de Salvert.—On the laws of reciprocity and the sub-groups of the arithmetical group, by M. X. Stouff.—Experiments on overflowed weirs, by M. H. Bazin.—On the fringes of caustics, by M. J. Macé de Lépinay.—On a phenomenon of apparent reflection at the surface of the clouds, by M. C. Maltézos.—On the electric figures produced at the surface of crystallised bodies, by M. Paul Jannetaz. If the face of a crystal be covered with matter consisting of light and small grains, such as lycopodium seed or talc powder, and an electric discharge passed into the face through a point outside it, certain figures are formed, many of which were investigated by Wiedemann and Senarmont. Very regular ellipses were obtained by M. Jannetaz by passing a series of discharges from an electrostatic machine or an induction coil. The orientation of the major axes of the ellipses was observed for a large number of minerals. In most cases this axis was perpendicular to the direction of maximum conductivity for heat. In the case of a well-defined single cleavage, such as that of mica, talc, a block of wood, the cut edge of a book, or a schistose rock, the major axis was perpendicular to the plane of cleavage. The point need not touch the plate. Figures were obtained on a plate of gypsum strewn with lycopodium powder, and charged from beneath. Positive and negative sparks show the same effect.—Action of temperature on the rotatory power of liquids, by M. Albert Colson.—Density of nitrogen dioxide, by M. A. Leduc.—Considerations on the genesis of the diamond, by M. J. Werth.—On the chlorine derivatives of the propylamines, the benzylamines, aniline and paratoluidine, by M. A. Berg.—On dipropylcyanamide and dipropylcarbodiimide, by M. F. Chancel.—Survival after section of the two vagi nerves, by M. C. Vanlair.—On the internal pericycle, by M. Léon Flot.—On a modification to be applied to the construction of bottles designed to collect specimens of deep waters, by M. J. Thoulet. The compressibility of water is such that one litre, collected at a depth of 8000 m. below sea-level, would expand by 35 cc. when the bottle was opened at the surface. Such bottles may therefore be constructed of thin sheet copper or other metal allowing an expansion of thirty-five parts in 10,000.—Lines of structure in the Winnebago County meteorite and some others, by Mr. H. A. Newton.—On a meteorite observed at Newhaven (Connecticut), by Mr. H. A. Newton.

CONTENTS.

THURSDAY, MARCH 2, 1893.

MODERN OPTICS AND THE MICROSCOPE.

The Microscope: its Construction and Management. Including Technique, Photomicrography, and the past and future of the Microscope. By Dr. Henri van Heurck, &c. English edition re-edited and augmented by the author from the fourth French edition, and translated by Wynne E. Baxter, F.R.M.S., F.G.S. (London: Crosby Lockwood and Son, 1893.)

THIS is a handsome, even a luxurious, book. It is beautifully printed on highly-finished paper, and with a margin ample enough to satisfy the most exacting connoisseur. The illustrations are clearly produced, the binding is admirable, and after a careful comparison with the last French edition, we do not hesitate to say that the translation is as felicitous as it is accurate.

Its author has aimed apparently at an elementary treatise on the microscope, which is nevertheless intended to cover almost the entire field involved in its history, production, and use. The difficulties of such a task are not a few. To be elementary and thoroughly popular up to a limit, very sharply defined, and then to lead on those who choose to follow into the deeper aspects of this many-sided subject, is at once practical and natural. The optics of the modern microscope are the possession of the specialist. Abbe himself has failed to make them accessible to and understanded by any but those educationally equipped. Hence the constant misunderstanding of the fundamental principles of the Diffraction Theory and its related applications so frequently manifest even where the subject is supposed to be more or less familiar.

As might have been readily supposed, the author of this treatise has given evidence of skill in the presentation of the main points of elementary optics; it is, however, clearness and conciseness, not originality, that is to be noticed. The illustrations are those familiar to English text-books for the last quarter of a century, and the diffraction theory has in no way been simplified to the reader of an elementary treatise by that most efficient of all elementary modes of imparting ideas on more or less abstruse subjects, viz. carefully devised and well-explained diagrams.

Considering the object of this treatise, viz. the impartation of knowledge to those not mathematically prepared to follow it in that direction, by giving a concise, clear, and comprehensive view of the meaning and application of the diffraction theory of microscopic vision, the transition from the first to the second chapter will be so abrupt and unlinked as to leave the elementary reader practically in the dark. The chapter on "The Theory of Microscopic Vision" is unexceptional so far as it goes. It cannot be other, it is Prof. Abbe's; but in a treatise claiming to maintain its elementary character more completely than any other similar work which covers so wide a range this is surely not enough.

The diffraction theory of vision is introduced to the tyro with no explanation of what diffraction is, and with no illustration of its action until he is plunged *in medias res* in Abbe's application of it to the profoundly important and inestimably valuable theory itself. The "elementary" character of this is at least questionable. Beyond this that most important factor in the diffraction theory in its practical application, Numerical Aperture, is wholly without explanation, save such as arises from its technical introduction and employment; but there are few points on which it is more important that an elementary student should be more clearly instructed, and there are few that lend themselves more to efficient diagrammatic presentation. In the same relation it may be noted that the very essential formula n sin u—expressing the general relation discovered by Abbe between the pencil of light admitted into the front of the objective, and that emerging from the back lens of the same, which is such that the ratio of the semi-diameter of the emergent pencil to the focal length of the objective could be expressed by the sine of half the angle of aperture (u) multiplied by the refractive index of the medium (n) in front of the objective or n sin. u—but this is a German mathematical formula; and its English equivalent is μ sin. ϕ, and although the German form of symbol is employed in England, and thoroughly understood by mathematicians, those who are entering for the first time upon a study of this difficult subject, and therefore unaccustomed to the mathematical formulæ employed, might readily fall into confusion, seeing that the "elementary" source of their information leaves them without a hint on the subject.

Another serious defect, as we believe, in this "elementary" presentation of the diffraction theory of microscopic vision is the absence of an easy explanation of the *photometrical* equivalent of different apertures. Certainly it is not of the essence of the problem, but it is just one of those points which in a very marked and instructive manner illustrate the meaning and value of numerical aperture as such; and for elementary exposition this must be of importance. Thus, if two circles be taken to represent the backs of two objectives of the same power but of different apertures, and the radius of one be twice that of the other, then each radius will represent the angle n sin. u. But because the areas of these circles are to each other in the proportion of the squares of their radii, it follows that if each radius be designated by n sin. u, the area of the lesser circle will be to the area of the greater circle as the square of the radius of the former is to the square of the radius of the latter. Hence the area of the greater circle will be four times as great as that of the lesser, which teaches that since the numerical aperture of one objective is twice as great as that of another its illuminating power will be *four times* as great—a most important incidental and explanatory *raison d'être* for great N. A.

In this connection we notice what is certainly not easily explicable as an exposition of the details of Abbe's great theory. On page 56 of "The Microscope" Dr. Van Heurck almost incidentally states the very important fact that "Prof. Abbe has satisfactorily established the fact that a certain relation must exist between magnification and angular (?) aperture." This is undoubtedly one of the most important demonstrations of the theory. Great numerical apertures have proved of untold value to the competent student of minute details, by opening up structures that mere amplification must have left for ever impenetrable. But that does not annul the import-

ance of small apertures. Low amplifications are as useful in their own department as high ones; and to put great apertures to lower magnifying powers than such magnifying power warrants is to sin against the elementary principles of the Abbe theory of vision. And on the other hand, wide apertures can never be utilised unless there is a concurrent and suitable linear amplification of the image which is competent to exhibit to the eye the smallest dimensions which are by optical law within the reach of such apertures.

Thus it follows that great amplification will be useless with small apertures. If the power be deficient the aperture will not avail; if the aperture be wanting nothing is gained by high power. The law is, "Employ the full aperture suitable to the power used." In Abbe's words, "A proper economy of aperture is of equal importance with economy of power." [1]

Taking these facts, then, which are apparently recognised by Dr. Van Heurck, it is very remarkable to find on page 49, in a discussion of the "screw threads" or gauges employed by the makers of microscopes, that the general value of the English gauge is admitted, but it is added, "The English thread is not, however, all that we have to say on this matter. In America the *American thread* is also employed, which is considerably greater, and admits the use of lenses with a much larger diameter, *and thus offers certain advantages.* In the first place, the larger the lens the easier it is to make, and consequently the real curvatures approach closer to the calculated curvatures; then the larger the lens the more luminous rays it admits, and this in photography is not to be despised."

To our judgment this statement is a contradiction of the admission made on page 49, quoted above.

The enlargement of the screw for the purpose of putting in larger back lenses to objective combinations was first mooted in America in 1879,[2] when "Mr. Bullock urged the desirability of adopting a uniform objective screw of larger size than the Society screw now in use (1879), as being essential to the efficacy of *low power lenses of high angle.*"

This "American gauge" was subsequently introduced and known as the "Butterfield gauge of screw for objectives." [3]

Now, we must remember the date of the introduction of this large gauge for objectives, and its relation to the introduction of the apochromatic system of lenses. We must further remember that the purpose of its adoption was to permit the introduction of larger back lenses than the Society gauge would suffer into an objective combination. This meant giving relatively great apertures to lower powers. But this, carried beyond a certain limit, violated a fundamental law of Abbe's theory.[4] Now it is said that these larger lenses are easier to make (!) and approach more nearly to the calculated curves. But in truth objectives with wide apertures which are low powers, and must therefore have large backs, are most difficult lenses to produce. It was, in fact, to escape the difficulty of giving lower powers larger angles that opticians of the first rank always designated their objectives as of lower magnifying power than they really were. They in fact made a $\frac{2}{3}$rds a $\frac{1}{2}$; a $\frac{1}{2}$ a $\frac{4}{10}$ths; a $\frac{4}{10}$ths a $\frac{1}{4}$; a $\frac{1}{4}$ a $\frac{1}{6}$; and so on.

Since Butterfield's gauge was introduced, long before the days of apochromatism, that is when our ignorance allowed us to over-aperture our low magnifying powers, it was tolerable, because it was evidence of experimental effort to improve the capacity of our lenses. But to-day *with* the society screw we are easily provided with a series beginning with a 1 inch objective of ·3, and a $\frac{1}{2}$ inch objective of ·65 N.A., and we may venture to think that these are the highest ratios of aperture to power that will be accomplished for many a day; and therefore the highest ratios allowable by the Abbe theory of vision, which we now know, at least in this point, to be an enunciation of the established laws of optics.

Moreover, *these* lenses are really difficult to make, with their back lenses easily placed within the diameter of the Society screw. A high ratio of aperture to power always involves great expense in production; and therefore we find that the *low-priced* oil immersions of this immediate time are $\frac{1}{12}$ths and $\frac{1}{8}$ths, not objectives of low magnifying power, and for this reason only.

Since then the Society screw is sufficient for more than double the apertures shown by Abbe to be in suitable ratio to the lower powers, we find it more than difficult to account for the teaching in a treatise intended to be essentially elementary, that the Butterfield screw gauge for objectives provides conditions which "offer certain advantages," when the supreme object of this part of the book is to enunciate fully the nature and qualities of oil immersion achromatic, and especially apochromatic, object glasses, by which we can get larger apertures with the society screw than in the old days of Butterfield's gauge could be got by the use of abnormal backs to objectives. We find also that "penetrating power" is referred to in passing as one of the properties of object glasses (p. 56); but since the diffraction theory of microscopic vision is associated with a special interpretation of what this means, and since it is to Prof. Abbe that we are indebted for placing this hitherto obscure matter on a sound, scientific basis, it somewhat disappoints the reader to find no allusion whatever to the valuable work done on this subject, nor any elementary endeavour to explain the great truth that the actual depth of vision must always be the exact sum of the accommodation depth of the eye and the focal depth of the objective. But there are few matters of more practical importance or that lend themselves more to simple exposition.

In a treatise purporting to be essentially for the beginner we confess to disappointment concerning the instructions as to the "choice of a microscope." What is needed is that the tyro should know the *essentials* of the instrument; the points in it that are of indispensable importance, and a clear account of the manner in which these may—by the uninitiated—be seen to be of inferior or acceptable workmanship. The reader is not even informed that in so important a matter as the *fine adjustment* there is a different value to be attached to several entirely different methods by which this function of the microscope is performed. The bar and lever movement, essentially the best in principle and practice, is only referred to as existing, in the index, which is thus

[1] J. R. M. S., ser. ii. vol. ii. p. 304.
[2] *American Naturalist*, vol. xiii. p. 60.
[3] J. R. M. S., ser. ii. vol i. p. 301.
[4] *Ibid.*, vol. ii. p. 204.

made to serve as a kind of glossary; and even more remarkable is the fact that the patent lever fine adjustment of Swift and Son, the only fine adjustment which, in our judgment, makes the "Jackson Model" microscope (which Dr. Van Heurck evidently affects) at all a practicable instrument, is treated in the same way. So indeed is Campbell's differential screw; and the highest commendation is given to the form adopted in the author's own model. No doubt in its present form it is relieved of many defects incident to the form of fine adjustment to which it belongs; but it must be remembered that we are told that each of the divisions of the milled head of this fine adjustment corresponds to the $\frac{1}{1300}$th of a millimetre. Yet the screw which gives this fine result has to lift the whole "body" of the instrument. In the lever fine adjustments only a nose-piece is lifted, having an inconsiderable weight, and producing in practice no friction, and to this the objective is attached; it certainly appears but reasonable, as it has proved in practice to workers who have employed the several methods for continuous years, that the "wear and tear" upon so fine a screw to which such heavy work is given does not contribute to permanent steadiness, or in constant work, to continued accuracy.

In fact, after careful study of the microscope specialised in this treatise, it is difficult to discover anything really new or distinctive in it save the bringing of the fine adjustment pinion of the sub-stage above the level of the principal stage. The value of this may be variously assessed, but it has the plain disadvantage of preventing the complete rotation of the principal stage; and it may be doubted if it has any advantage which will compensate for this.

There is little, if anything, to enable the reader to distinguish as to the practical value of one form of stand as compared with another, and yet there can be no greater divergence in form than that between the Continental stand on the one hand with its dead weight to produce steadiness, and the two English models known as the Ross and Jackson models respectively on the other. What distinguishes them, in what either of them has superiority over the other, and wherein in any of them what is essential to a first-rate working microscope, is nowhere discussed.

It is true that the models of many makers are presented and beautifully printed; but many of these are not printed in these pages as revealing essential differences important for the reader to observe, but they are placed amongst others simply as the productions, with slight variations, of the same instruments by different makers. We cannot but believe that if some plain directions had been given as to the essentials of a good microscope, and the principal models passed in review showing their conformity or otherwise to these requirements, the "elementary" object of the book would have been more fully accomplished, and the tyro more fully aided in the "choice of a microscope."

Dr. Van Heurck has shown his practical knowledge of the microscope as a manipulator in many ways, in this book, but perhaps this is nowhere more fully seen than in his full appreciation of the *condenser* as an indispensable instrument in bringing out the finest optical possibilities of the most perfectly constructed object glasses. His book may be said to be alone amongst continental treatises on the microscope in this respect. It has been by very tardy steps that the continental makers, or the continental microscopists, have learned to appreciate the immense importance of a condenser in causing optical combinations to give their highest results. It is but recently that so leading a firm as Zeiss has yielded on this point and produced condensers. The first was chromatic, and, as a consequence, proportionately unsatisfactory. Then came the most useful achromatic form of Abbe. But we are glad to observe that Van Heurck recognises that the *apochromatic* immersion condenser of Powell "is the most perfect condenser which exists at present" (p. 85). It is inevitable that with apochromatic objectives it should be. We cannot possibly see how the splendid objectives on apochromatic principles can give their finest results unless they are illuminated by an apparatus which is not only as perfect in workmanship, but of as great a numerical aperture, and with as complete corrections as the objective which is collecting the light and forming the image of the object the condenser is illuminating.

And for this reason, while we admit fully that the plate of photo-micrographs produced in this and other volumes by the very exceptional skill of Dr. Van Heurck with the most remarkable object glass which the manipulative skill of man has yet produced, viz. the 2·5 mm. with N.A. 1·63, is a monument to his manipulative ability, we still contend that he worked under difficulties of no small importance. The only condenser provided for this lens by the great firm which produce it, is one which of necessity has a flint front, but is as wholly uncorrected as the glasses used by Hooke or Bonanni!

Now if it be important to use an apochromatic condenser at all, how much more important to use it on such a lens, with such an aperture and such exquisitely refined corrections. This objective has never yet had its best power revealed, because its illumination has been always a counteraction of its own refinements.

We are surprised that in manipulation the tyro is recommended in this treatise to focus *down* upon the object first, of course with great care, and then to find the actual focal point by withdrawing the tube by either coarse or fine adjustment. A far more elegant and safe method is certainly adopted, and we doubt the preference expressed for daylight as the best constant source of illumination. It is uncertain and always variable and more refractory than the edge of a good lamp-flame, unless we need a monochromatic ray from a sunbeam.

At the close of the book there is a communication which had appeared before in the Journ. Roy. Micro. Soc., from Dr. S. Czapski, which gives a suggestion for the possible enlargement of the practical N.A. of homogeneous object-glasses, which makes an advance to 2·0 possible without the employment of the dense flint and highly refractive media needed by the lens spoken of above. In fact it is plain that true monochromatic light may increase a N.A. of 1·40 to 1·75.

There is a chapter on photomicrography which has the value that is inevitable, coming as it does from one of the most practised and efficient workers; still it can hardly be expected to be exhaustive, and every practical photomicrographer has, and adopts as most perfect, his

own methods; and as none will ever become photo-micrographers who have not some ingenuity and enthusiasm, it is only needful that they be set to work, and they will undoubtedly find *their own* "best methods."

This treatise is too general to expect from it more than useful and suggestive hints on the subject of the preparation and mounting of objects; and the same may be said as to the history of the microscope, which is nevertheless given in an interesting and useful manner. The book will undoubtedly attract many readers, and it will afford help to many who are seeking it; but we respectfully doubt whether it will enable the elementary reader to fully follow the diffraction theory of microscopic vision, so as to be able to understand its application to the wide range of subjects supposed to be dealt with from that point of view by this sumptuous treatise.

W. H. DALLINGER.

A UNIVERSITY EXTENSION MANUAL.

The Earth's History: an Introduction to Modern Geology. By R. D. Roberts, M.A. (Camb.), D.Sc. (Lond.). With Coloured Maps and Illustrations. (London: John Murray, 1893.)

THIS is not a large book, and a slightly less ambitious title might have been more appropriate. Certainly it is an introduction to the study of modern geology rather than a history of the earth, for the latter is regarded from a limited point of view. But from the page preceding the frontispiece it appears that the volume is one of a series of "University Extension Manuals." It partakes, therefore, of the advantages and disadvantages of this method of disseminating knowledge.

The topics treated by Dr. Roberts are the progress of geological thought: the beginnings of the earth's history: the modifications of its surface due to forces destructive and reproductive: the movements of its crust, including the action of volcanoes. Finally he deals with the formation of rock masses, and attempts to give—though of necessity this subject is very imperfectly treated—some idea of the evolution of the British Islands.

The materials employed by the author are not generally novel, for one text-book must draw from much the same storehouse as another, but Dr. Roberts has a lucid and pleasant method of statement, gained no doubt by his experience in the lecture room. One point, however, though it relates to a well-worn subject, will be fresh to most readers. In speaking of the submergence of the so-called Temple of Serapis at Puzzuoli, Dr. Roberts cites a passage from the Acts of Peter and Paul, an apocryphal booklet, to which attention was drawn a few months since by Mr. Thomson (*Geol. Mag.*, 1892, p. 282). This states that Pontioli (Puteoli, now Puzzuoli) was submerged as a punishment for the martyrdom of Dioscurus. "They all see that city Pontioli sunk into the sea-shore about one fathom, and there it is unto this day for a remembrance under the sea." On which passage Dr. Roberts observes that when the Acts was written, "Puzzuoli was under water, and had been so for so long a time that the memory of the actual events had been lost and replaced by the tradition recorded in the Acts." At first sight this, as he says, seems in favour of the submergence having occurred "between the third and fifth centuries, and probably earlier than the fourth."

This passage certainly makes it probable that the submergence began at a rather early time, but it is no easy matter to fix the date of any passage in these Acts. Parts of the book are believed to be as old as the second century, while others are not earlier than the fifth century. The book, also, was not of Western but of Eastern origin. Had the book been written in Italy then, notwithstanding its other absurdities, some weight might be attached to a topographical reference; but these, as it was compiled at a distance, and by obviously ignorant people, seriously impair its credit. It is also needful to show that this story forms part of the later recensions and is not merely founded on some vague tradition of change of level in the neighbourhood. In any case, Dr. Roberts seems to go a little too far in saying "this would allow about ten centuries, during which the marble columns were under water exposed to the action of the living molluscs." Hardly so; this tradition at most would not take us beyond the first submergence, that indicated by the brackish water deposit at the base of the pillars. Over this came an irregular mass of volcanic ash, which was covered by a calcareous tufa, in places full four feet thick. The former, of course, may have accumulated in a few hours, but the latter must indicate a considerable time. The temple, also, must have been in complete ruin before the showers of ashes fell—which also would require time. So that Dr. Roberts perhaps would have done better to have adhered to the more cautious statement in Mr. Thomson's letter, and not claimed quite so long a period for the maximum submergence.

Within the limits, which the necessities of the case impose, the book is well conceived and well executed: though we cannot help doubting the wisdom of encouraging, by manuals necessarily partial and incomplete, students to imagine that they have really mastered a subject; at any rate, it should be frankly admitted that this, however useful and interesting, is not education.

OUR BOOK SHELF.

The Health Officer's Pocket-Book. By E. F. Willoughby, M.D., D.P.H. (London: Crosby Lockwood and Son, 1893.)

THIS is a work the object of which is to provide a portable and well-bound book of reference, to which the health officer may turn at any moment for most of the facts, formulæ, and data required in his daily practice; and while one cannot give unqualified assent to Dr. Willoughby's contention that such a book is indispensable, one is prepared to acknowledge that it may prove to be useful. It is not easy, however, to conceive the conditions under which a health officer is called upon to take action or to give advice, at a moment's notice, upon points so remote from the routine practice of his duties that he will ever find it necessary to carry about, for consultation, a pocket-book of abstruse sanitary facts and formulæ and legal enactments. If such a work is indispensable, the author would have done well to restrict its bulkiness somewhat, and more especially since he could have achieved this by the omission of a great deal of matter which is, on the face of it, foreign to the purpose of the book. To instance such:—The parts which nitrogenous and non-nitrogenous food stuffs play in the animal economy; the origin and nature of cyclones; a quantity

of discursive material upon vital statistics; and a host of elementary hygienic facts with which every sanitarian is conversant,—are none of them points it can ever be necessary for the health officer to carry about with him for hasty reference.

The most useful sections, and those which most justify the *motif* of the book, are the following:—Those which deal with mathematical problems, and set forth useful algebraical and trigonometrical formulæ, together with a few logarithm tables; that upon demography and vital statistics; and the serviceable abstract of sanitary law, in which corresponding or similar sections of the Public Health Act, 1875, and the Public Health (London) Act, 1891, are considered side by side.

There is very little in the book which is not correct and up to date, save that which refers to the subject of water analysis. This contains many errors, and, since the utility of its introduction is very questionable, it is regrettable that it mars the all-round accuracy of the work. In this section Dr. Willoughby gives several results of his own analyses, and those who are familiar with the subject will find their experiences much at variance with the writer's.

In what he calls a typical sample of *rain-water* he found 0·63 grains per gallon of nitrates as HNO_3, and 0·114 and 0·172 parts per million of "ammonia" and "albuminoid ammonia" respectively; in *river-water* at Latchford he found no nitrates, not even a fraction of a part per million, and the "ammonia" and "albuminoid-ammonia" were 0·08 and 0·16 (parts per million) respectively. Loch Katrine water is, moreover, credited (and Wanklyn is quoted as the authority) with 0·008 parts per million of "albuminoid-ammonia," and with 0·004 of "ammonia;" and the former is said to correspond to 0·0056 grains per gallon!

While unquestionably the work contains some material which will make it useful to the health-officer, the health student will find much in it which he may peruse with advantage.

Engler's Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie. (Leipzig: W. Engelmann.)

SINCE Dr. A. Engler's appointment to the post of Director of the Berlin Botanical Garden and Museum, this periodical has become the organ of the very active staff of botanists of that establishment; and the comparatively recent German colonial policy has revived the interest in systematic and economic botany, to which it is devoted chiefly. Vols. xv. and xvi. are being published concurrently. This publication is partly devoted to original work and partly to a review of contemporary botanical literature. The fifteenth volume is largely taken up by contributions to the flora of tropical Africa, in the form of an elaboration by various botanists of the extensive collections made by numerous German travellers. Quite a host of new species are described, but, truth to say, nothing very remarkable in new generic types. *Hybophrynium* is a new genus of Scitamineæ, near *Trachyphrynium*, with which it was generically associated by Bentham and Hooker; and the Aroideæ, elaborated by Engler himself, include two or three new genera. *Pseudohydrosme* is characterised by a large, almost truncate spathe and a spadix without any terminal naked continuation.

Dr. J. Urban, who has been for some years engaged in collecting materials for a general flora of the West Indies, contributes "Additamenta ad Cognitionem Floræ Indiæ Occidentalis," a critical work, both from a botanical and a literary standpoint. No new genera are described.

One of the most interesting articles in the sixteenth volume is by Dr. O. Warburg, on the mountain plants of Kaiser Wilhelm's-Land, New Guinea. The collection of plants dealt with consisted of only fifty-three species, whereof thirty-two were supposed to be endemic, though the material of a few was insufficient for description. Two new genera are described, namely, *Hellwigia pulchra*, a pretty scitamineous plant, and *Zoelleria*, a singular boragineous plant, described as having ten nutlets in the place of the usual four! Among the new species are five rhododendrons, and the most noteworthy feature of the collection was the absence of essentially Australian types.

Another paper of general interest is Dr. Kränzlin's "Beiträge zu einer Monographie der Gattung Habenaria," excluding *Platanthera*, united with *Habenaria* by some botanists, 347 species are described; and they are spread over nearly the whole area inhabited by orchids.

Dr. Carl Bolle's "Botanische Rückblicke auf die Inseln Lanzarote und Fuertaventura" is a pleasantly written essay on the indigenous and cultivated plants of these islands. The "Jahrbücher" contain many other valuable articles. W. B. H.

Descriptive Geometry Models for the use of Students in Schools and Colleges. Designed by T. Jones, M.I.M.E. (Moss Side, Manchester.)

THE models are six in number. They are intended to show a line (1) by its projections, (2) by its traces; the inclination of an oblique plane (3) to the vertical plane, (4) to the horizontal plane; and to determine the angle (5) between two intersecting lines (6) between two planes. They are accompanied by hints for fixing and studying the models, and with a useful list of problems suggested as exercises for students. The clearness of the explanations, the simplicity of the constructive apparatus, and the compactness of the arrangements (all being contained in a handy cardboard box) commend Mr. Jones's work to students of solid geometry.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Lion-Tiger Hybrids.

I HAVE read Dr. Ball's account of this subject in the issue of NATURE for February 23, 1893, and beg leave to call attention to the fact that the University of Cambridge possesses the skeleton and the stuffed skin of an *adult* hybrid between a lion and a tigress. I am able to supply the following information (which I have verified so far as it was possible) with regard to this specimen from a contemporary MS., entitled "Notice of the Lion-tiger which died in Cambridge, March 1833," by J. B. Melson, then an Undergraduate at Trinity College. This MS. no doubt contains the substance of a paper by Mr. Melson, which was communicated by Dr. Haviland to the Cambridge Philosophical Society, May 6, 1833. The paper was unfortunately not printed in the Transactions of the Society.

The Cambridge specimen, like those mentioned by Dr. Ball, was procured from the menagerie of Mr. Atkins. It was about six years old, and for some time previous to its death had been affected with paralysis of its hind quarters, arising probably from a distortion of the lower thoracic region of the vertebral column [which is still a marked feature of the actual skeleton]. Although inferior in size to either of its parents, the animal appeared to have attained its full dimensions. The shape of the head resembled that of the father (the lion), whilst the form of the body was more similar to that of the tigress. The body was faintly striped, while the prevailing shade was "of a dingy lion colour." The animal had neither a mane nor a tuft at the end of its tail.

The specimen was a female, and Mr. Melson states that "all the individuals of this hybrid race have as yet been females." The orifice of the vagina was smaller than in the tigress; and

the uterus was "merely rudimentary and nothing more than a membranous tube terminating in the two fallopian tubes." The ovaries were normal in appearance, though very much smaller than those of the full-grown lioness or tigress.

The extreme length of the skull, from the end of the occipital crest to the end of the præmaxillæ, of the specimen now in the Cambridge Museum, is 290 mm.; the distance between the foramen magnum and the end of the præmaxillæ is 235 mm.; and the extreme zygomatic breadth is 190 mm. The ascending process of the maxilla ends at a point 3 mm. in front of the posterior end of the nasal bones, and has a somewhat rounded termination. In these characters the skull of the hybrid resembles that of the lion much more closely than that of the tiger. S. F. Harmer.

University Museum of Zoology, Cambridge, February 27.

Travelling of Roots.

The mode in which roots travel in pursuit of food (moisture) is often remarkable. Innumerable instances have been published. But I think the inclosed is one of the most striking which I have come across. The specimen kindly sent to the Kew Museum by the vicar of Petersham is most extraordinary. The roots seem to have behaved more like the mycelium of a fungus than an ordinary axial structure.

W. T. Thiselton-Dyer.

Royal Gardens, Kew, Feb. 24.

Memorandum by the Rev. W. H. Oxley, Vicar of Petersham, dated February 16, 1893.

Roots of a Wistaria from the dining-room of Eden House, Ham, just demolished.

The root entered the room by a very small chink in the side of the window, near the ceiling, and on removing the paper, which had not been disturbed for many years, from the walls (of the room about 14ft. square) the whole of the plaster beneath the paper was found covered with a fine network of roots spreading all round the room. The specimen is about one-third of the whole roots and the stem where it entered the room. There was not the faintest appearance of anything of the sort on the surface of the wall paper to give rise to the suspicion of these roots being there, and the room was continually inhabited, with fires, &c.

The Flight of Birds.

With reference to an extract from *Science* on the flight of birds, which appeared in your "Notes" of February 16, I agree with the writer of that extract that the rapidity with which the generality of birds travel is often considerably over-estimated.

Some few months ago, whilst crossing, by G.W.R. express, the moors of Bridgewater Level in Somerset, a couple of turtle-doves rose at a distance of about eighty yards from the train, and flew for a considerable distance in a line nearly parallel with the rails.

I observed them with much interest, for I wished to have some comparison of their power of flight with that of some "homing" pigeons in my possession, and perceived that they were being slowly overtaken. They must have flown fairly parallel with the line of rails for at least 500 yards, and finally bore away northward. We must have been travelling at about forty miles an hour at the time, so that their speed would have been a little less than that. I was the more surprised at this as I had had "homing" pigeons, trained by myself, which, on a clear, calm day, had flown from the Quantock Hills to Taunton (a distance of seven miles) in less than eight minutes—a quite superior rate of flight, which, however, I do not think they would continue for a long distance. The Columbacei generally may be considered good flyers; the turtle, however, I believe from observation to be somewhat below the average standard of excellence. It certainly cannot be compared with the Passenger Pigeon of America, which has frequently been killed in the neighbourhood of New York with Carolina rice still undigested in its crop—having probably accomplished a journey of between 300 and 400 miles in about six hours, giving the high record of sixty miles an hour for six hours in succession. My own impression is that there is a great difference in the speeds of various orders and tribes of birds. I have repeatedly observed the fieldfare, which is a fairly strong flyer, overtaken by trains of which I have been an occupant, and which could not have been travelling more than forty miles an hour. On the other hand, I have witnessed the pursuit of a wood-pigeon or cushat by a hawk, in which both birds exhibited powers of flight which might seem incredible to persons unobservant of nature. In this instance I should have estimated the speed of the pigeon, which was straining every muscle to reach the shelter of a belt of timber, to be about sixty miles an hour; whilst that of the hawk, which flew with little effort, could not I think have been less than eighty, during the brief period that they were within my sight. I should be glad to hear from any of your correspondents their opinion as to the rapidity of flight in the Raptores (British). Herbert Withington.

Taunton, February 22.

The Niagara Spray Clouds.

I do not remember having seen anywhere a reference to the fact that the spray clouds of Niagara exhibit an ice bow in clear frosty weather.

I had an opportunity last week of seeing a very fine complete bow, the inner one, the outer being absent.

There was no trace of the mock suns or of the bands of white light usually present; though I have seen ice bows without the latter, I have never seen one before without any trace of mock suns; these are generally accounted for by supposing the presence of hexagonal ice prisms. I would suggest the inference that the ice crystals in the Niagara spray clouds are not prisms but rhombs. Chas. A. Carus-Wilson.

McGill University, Montreal, February 6.

British New Guinea.

In Nature (vol. xlvii. p. 345) Mr. H. O. Forbes has a lenient review of Mr. J. P. Thomson's "British New Guinea," in which he reproduces a figure of four natives. In the original they are called "native mountaineers" (p. 95). As a matter of fact only the two central men are mountaineers; the two outermost being coast natives who acted as decoys to induce the timid highlanders to submit to being photographed. Mr. Thomson has a reprehensible habit of inserting figures which, while they illustrate the contiguous text, really belong to a different part of British New Guinea than that there dealt with. I fancy Mr. Forbes has been deceived in this respect, for the last figure which appears in the review is entitled by Mr. Thomson "Native Ornaments" (p. 120), and, though occurring in his description of the Fly River district, represent, if I am not mistaken, Papuan Gulf natives, most probably Motu-Motuans. Alfred C. Haddon.

I quite agree with Prof. Haddon's remarks above, which you have been good enough to submit to me, with regard to the mountaineers of the interior of New Guinea. They enter into details which, in an already over-long review, I had no space for. There is no donbt about the right-hand figure (p. 346) being *not* a mountaineer. I was less confident about the man on the left hand. The *two central figures* recall to me perfectly the people of Uburukara, of whom I took photographs in 1886, the plates of which were ruined during my disastrous march down the Goldie, and it was they who specially attracted my attention. With regard to the "Fly River" natives, I have never had the fortune to see any of them, but I certainly took the central figure to be one, while remarking to myself the likeness of the right-hand man to a Motuan—to men with whom he could be matched in any village indeed between the Gulf and Kerepunu.

104, Philbeach Gardens, S.W. Henry O. Forbes.

Some Lake Basins in France.

I regret that, through some inadvertence on my part, the name of the author of the "Atlas des Lacs Français," mentioned in my letter (p. 341) is wrongly printed. It should be Delebecque. In a letter received from M. Delebecque, he informs me that "the direction of the arrow on the map of Lake Léman is not exactly N., but N. 7° W." He informs me also that the curious funnel-shaped hole at the northern end of the Lake of Annecy, which I suggest may be a submerged swallow hole, is the site of a spring. This fact, however, need not be fatal to my suggestion, because the changes in level might convert what was once a swallow-hole into a spring. At present water at one time flows up from the dolinas of the Julian Alps, at another it drains off down them. T. G. Bonney.

ON ELECTRIC SPARK PHOTOGRAPHS; OR, PHOTOGRAPHY OF FLYING BULLETS, &c., BY THE LIGHT OF THE ELECTRIC SPARK.[1]

I.

WHEN I was honoured by the invitation to deliver this lecture I felt some doubt as to my ability to find a subject which should be suitable, for there is a prevailing idea that in addressing the operative classes, it is necessary to speak only of some practical subject which bears immediately upon the most important industry of the place in which the lecture is being delivered; but it seems to me that this is a polite suggestion that the audience are unable to be interested by any subject except that particular one which occupies them daily. Now though I am a comparative stranger in Scotland I have heard quite enough, and I know quite enough, of the superiority of the education of you, who have the good fortune to live in this the most beautiful half of Great Britain, to be aware that, as is the case with all highly-educated men, you are able to take a keen and genuine interest in many subjects, and that I had better choose one to which I have specially devoted myself, if I do not wish to expose myself to the risk of being corrected. I will ask you therefore in imagination to leave your daily occupation and come with me into the physical laboratory, where, by the exercise of the art of the experimentalist, problems which might seem to be impossible are continually being solved. I wish as an experimentalist to present to you an example of experimental enquiry.

Let us suppose that for some reason we wish to examine carefully and accurately some moving object travelling, if you will, at so great a speed that, observed in the ordinary way, it appears as a mere blur, or perhaps at a speed so tremendous that it cannot be seen at all. In such a case, in order to get a clear view of the moving body we may either look through an aperture which is only opened for a moment as the body passes by, or we may suddenly illuminate the object by a flash of light when it is in a position in which it may be seen. If in either of these cases the hole is open, or the illumination lasts so short a time that the object has no time to move appreciably while it is in this way brought into view, we get what may in ordinary language be called an instantaneous impression and the object appears clear, sharp, and at rest. In the same way if we wish, with the object of obtaining a permanent record, to photograph a moving body we must either allow the eye of the camera to see through a hole for a moment, *i.e.* we must use a rapid shutter, and many such are well known, or we must, keeping the photographic plate exposed and the object in the dark, make a flash of light at the right time. As before, if the shutter is open or the flash lasts so short a time that the object cannot move appreciably in the time, then, if any impression is left at all it will be sharp, clear, and the same as if the body were at rest. The first method, that of the shutter, I do not intend to speak about to-night, but as, owing to the kindness of Mr. F. J. Smith, I have with me the most beautiful example that I have seen of what can be done by this method, I thought perhaps I should do well to show it. Mr. Smith was in an express train near Taunton, travelling at forty miles an hour, and when another express was coming up in the opposite direction at sixty miles an hour, *i.e.* approaching him at one hundred miles an hour, he aimed his camera at it and let a shutter of his own construction open and shut so quickly that the approaching train was photographed sharply. There is a special interest about this photograph; it shows one of the now extinct broad-gauge engines on the road. However, this is an example of the method which we shall not consider this evening.[2]

[1] Lecture delivered at the Edinburgh meeting of the British Association by C. V. Boys, F.R.S.

[2] I have heard that a cannon-ball has been photographed by means of a rapid-shutter, but I have no direct information on the subject.

For our purpose we require what is called instantaneous illumination,—a flash of light. It is of course obvious that it depends entirely upon the speed of the object and the sharpness required, whether any particular flash is instantaneous enough. No flash is absolutely instantaneous, though some may last a very short time.

For instance, a flash of burning magnesium powder lasts so short a time that it may be used for the purpose of portraiture, and while it lasts even the eye itself has no time to change. The lower part of the second slide (Fig. A) is a photograph of the eye of Mr.

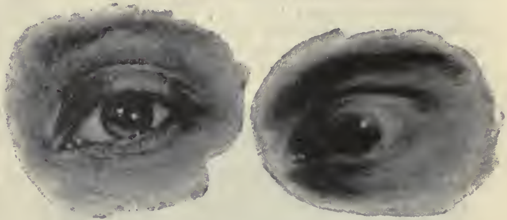


FIG. A.
Lower part. Upper part.

Colebrook after he had been some minutes in a dark room, taken by the magnesium flash; the upper part is the same eye taken in daylight. The pupil is seen fully dilated and the eyelid has not had time to come down, and so we might reasonably say that the flash was instantaneous; it was for the purpose practically instantaneous. Yet when I make this large clock-face four feet across revolve at so moderate a speed that the periphery is only travelling at forty miles an hour and illuminate it by a magnesium flash you see no figures or marks at all, only a blur. Thus the magnesium flash, which for one purpose is practically instantaneous, is, tested in this simple way, found to last a long time. Let me now, following Lord Rayleigh, contrast the effect of the magnesium flash with that of a powerful electric spark. At each spark the clock-face appears brilliantly illuminated and absolutely at rest and clear, and if it were not that I could at once illuminate it by ordinary light it would be difficult to believe that it was still in motion.

The electric spark has been often used to produce a flash by means of which phenomena have been observed which we ordinarily cannot see. For instance, Mr. Worthington has in this way seen and drawn the exact form of the splash produced by a falling drop of liquid.

Mr. Chichester Bell, Lord Rayleigh, Mr. F. J. Smith, and others have used the illumination produced by an electric spark to photograph phenomena which they were investigating. I am able to show one of Lord Rayleigh's, a breaking soap-bubble, in which the retreating edge, travelling something like thirty miles an hour, is seen with all the accuracy and sharpness that is possible with a stationary object. Mr. F. J. Smith has extended the use of sparks for the purpose of physiological enquiry, taking a row of photographs on a moving plate at intervals that can be arranged to suit the subject, and is thus putting in the hands of the much-abused experimental physiologist a very powerful weapon of research. I had hoped to show one of these series of an untechnical character, to wit, a series taken of a cat held by its four legs in an inverted position and allowed to drop. The cat, as every one is aware, seems to do that which is known to be dynamically impossible, namely, on being dropped upside down to turn round after being let go and to come down the right way up. The process can be followed by means of one of Mr. Smith's multiple spark photographs. However, his cats do not seem to like the experiments, and he has in consequence had so much trouble with them that his results,

while they are of interest, are not, up to the present, siutable for exhibition.

Let me now return to single spark photographs. We have seen that the magnesium flash, which for the purpose of portraiture is practically instantaneous, yet fails to appear so when so moderate a speed as forty miles an hour (and indeed a far lower speed) is used for the purpose of examining it. Is anything of the kind true in the case of the electric spark? Will the spark, by which we saw the clock-face absolutely sharp, after all fail to give a sharp view when tested by a much higher speed? I have taken such a spark and attempted (though I knew what the result would be) to photograph by its light the bullet of a magazine rifle passing by at the rate of about 2100 feet a second, or, what is the same thing, at about 1400 miles an hour; the result (Fig. 1) shows not a clear sharp bullet but a blur; the spark lasted so long a time that this bullet was actually able to travel half an inch or so while the illumination lasted. Thus we see, that if we wish to examine bullets, &c., in their flight, any electric spark will not necessarily do. We shall have to get a spark which while it gives enough light to act on the plate yet lasts so short a time that even a rifle bullet cannot move an appreciable distance during the time that it is in existence.

Fig. 1.

A knowledge of electrical principles enables one to modify the electrical apparatus employed to make this spark in such a manner that its duration may be greatly reduced without, at the same time, a very great sacrifice of light; but while this may be done it is important to be able to observe how long the spark actually lasts, when made by apparatus altered little by little in the proper manner. The desired information is at once given by the revolving mirror. For instance, every one is aware how, by a turn of the wrist, one may reflect a beam of sunlight from a piece of looking-glass so as to travel up the street at a most tremendous velocity; but suppose that, instead of being moved by a mere turn of the wrist, the mirror is made to rotate on an axle by mechanical means at an enormous speed; then, just as the rotation is more rapid, so will the beam of light travel at a higher speed. In the particular case that I am going now to bring before your notice, a small mirror of hardened steel was made by Mr. Colebrook, the mechanical assistant in the physical laboratory at South Kensington, mounted so beautifully that it would run at the enormous speed of 1000 turns a second (not 1000 a minute) without giving any trouble. The light from the spark was focussed by the mirror upon a photographic plate. Now if the light were really instantaneous, the image would be as clear and sharp as if the mirror were at rest; if, on the other hand, it lasted ong enough for the image to be carried an appreciable distance, then the photograph would show a band of light drawn out to this distance. The mirror is now placed on the front of the platform, and a beam of electric light is focussed by it upon the screen, from which it is distant about 20 feet. Now that I turn the mirror slowly, you see the spot of light drawn out into a band reaching across the screen, and this is described over and over again as the mirror revolves. Let us suppose that the mirror is revolving once a second, then it is easy to show that the spot of light is travelling at about 250 feet a second. It is not difficult therefore to see that if the mirror is revolving 1000 times as fast, the spot of light will traverse the screen 1000 times as fast also, *i.e.*, about 250,000 feet a second, or 160,000 miles an hour—a speed which is 200 times as great as that of a Martini-Henry bullet, while such a bullet only travels 14 times as fast as an express train. You will see, then, that it is not difficult to observe how long a spark lasts when its image can be whirled along at such a speed as this. I have now started the electro-motor, and the mirror is turning more and more rapidly. Now it gives a musical note of the same pitch as that given by the tuning-fork I am bowing; it is therefore turning 512 times a second. It is now giving a higher note, *i.e.* it is turning faster and faster, until at last it gives the octave, at which time it is turning 1028 turns a second. The band of light on the screen is produced by a spot now travelling at a still higher speed than that which I have just mentioned. I had hoped to have shown with this apparatus the actual experiment of drawing out the apparently instantaneous flash of an electric spark into a band of light, but I found that while it was easy to show the experiment in a small room, the amount of light was not sufficient to be seen in a great room like this. I must therefore be content to show one or two of the photographs which were taken lately in the physical laboratory at South Kensington by two of the students, Mr. Edser and Mr. Stansfield, whom I now take the opportunity of thanking. The next slide shows the drawn-out band of a particular spark made between magnesium terminals by the discharge of a condenser of $2\frac{1}{2}$ square feet of window-glass, the spark being $\frac{1}{8}$ inch long. Below the drawn-out band I have drawn a scale of millionths of a second. If the spark had been instantaneous it would have appeared as a fine vertical line. This line, however, has been drawn sideways to an extent depending on the duration of the spark. The spark, except at the ends, is extinct in rather less than one-millionth of a second, but the ends remain alight like two stars, being drawn out in consequence into two lines, which have lasted, as measured by the scale, as long as six or seven millionths of a second. Such a light is, therefore, seen to last when tested with this very powerful instrument so long that it seems absurd to call it instantaneous. It lasts too long for the purpose of bullet photography. In order to get sparks of shorter duration it is necessary to abolish the metal magnesium, in spite of the brilliant photographic effect of the two ends of the spark between knobs of this material, it is well to avoid all easily volatile metals, such as brass, because of the zinc that it contains, and instead to employ beads of copper or of platinum. In the second place, the duration of the spark proper, which in the last case was nearly a millionth of a second, can be reduced by (1) reducing the size of the condenser, but one must not go too far, as the light is reduced also; (2) by replacing any wire through which the discharge may have taken place by broad bands of copper as short as possible, this has the further advantage of increasing the light; and (3) the light may be increased without much change being made in the duration by making a second gap in the discharge circuit, the spark in which, however, must be hidden from the plate. Fig. 2 shows the trail of the best spark for the purpose of bullet

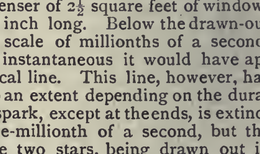


Fig. 2.

photography that I have obtained up to the present. In this case the surface of the condenser is one square foot, and the discharge is taken through bands of copper about two inches broad, and not more than about four inches long apiece. Extra good contact is made between these copper bands and the tin-foil surface by long radiating tongues of copper-foil soldered to the end of the copper bands. The knobs are platinum, but this seems no better than copper. The whole of the light is extinct in less than one-millionth of a second, while the first blaze, which is practically the whole spark, the tail being in comparison of no consequence, does not last so long as a ten-millionth of a second; in other words, it lasts so short a time that it bears the same relation to one second that one second bears to four months; or again, a magazine rifle bullet, travelling at the enormous speed that is now attained by the use of this weapon, cannot go more than one four-hundredth of an inch in this time. Other sparks of still less duration were examined, but this was chosen for the purpose of photographing bullets.[1]

Now, having obtained a suitable flash of light, I must next show how a spark may be used for the purpose of photographing a bullet in its passage This was first done by Prof. E. Mach,[2] of Prague, whose method is illustrated by the diagram Fig. 3. The squares on the

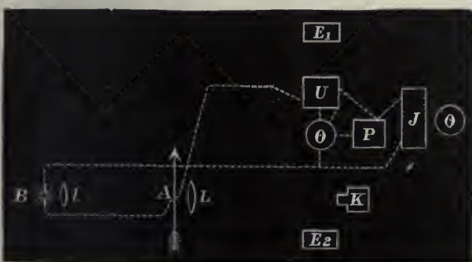


Fig. 3.

right-hand side represent certain electrical apparatus by means of which a Leyden jar (J) is charged with electricity to such an extent that, while it is unable to make two sparks at B and A, it is nevertheless able to, and at once will, make a spark at B when the second gap at A is closed by a bullet or other conductor. The dotted lines represent wires through which the discharge then takes place. The spark at B, magnified by the lens *l* in front of it, then fills the field lens L with light, so that the camera K focussed upon the spark gap A will then receive an image of the bullet as it passes, and thus a photograph is secured. I am able to show two of these which Prof. Mach has kindly forwarded to me, and what I wish to point out is that in each of these photographs—and this is perhaps the most interesting feature which any of these exhibit—there are seen, besides the bullet and the wires which the bullet strikes in its journey, certain curious shades, one in advance of the bullet and one from the tail, while a trail is left behind very like that seen in the wake of a screw steamer. In fact, the whole atmospheric phenomenon accompanying the bullet is not unlike that seen on the surface of water surrounding and behind a steamship. These were seen for the first time, and their visibility by this method was, I believe, predicted by Prof. Mach before he made his first experiment.

The part that I have played in this matter is after all very subordinate. I have attempted to simplify the means, and the results which may be obtained by the modified method which I have devised, are, I believe, in some respects—I don't say in all—clearer and more instructive than those obtained by the more elaborate device of Prof. Mach.

Fig. 4 is a diagram of the apparatus that I have used. C is a plate of window-glass with a square foot of tin-foil on either side. This condenser is charged until its potential is not sufficient to make a spark at each of the gaps E and E′, though it would, if either of these were made to conduct, immediately cause a spark to form at the other. *c* is a Leyden jar of very small capacity connected with C by wire, as shown by the continuous lines, and by string wetted with a solution of chloride of calcium, as shown by the dotted line. So long as the gap at B is open this little condenser, which is kept at the same potential as the large condenser by means of the wire and wet string, is similarly unable to make sparks both at B and E′, but it could, if B were closed, at once discharge at E′. Now suppose the bullet to join the wires at B, a minute spark is made at B and at E′ by the discharge of *c*, immediately C, finding one of its gaps E′ in a conducting state, discharges at E, making a brilliant spark, which casts a shadow of the bullet, &c., upon the photographic plate P. Though this is simple enough, the ends that are gained by this contrivance are not so obvious. In the first place the discharge circuit of C, via E and E′ is made of very short broad bands of copper, a form which favours both the brilliancy and the shortness of duration of the sparks; further, the double gap, of which E′ may be the longer, causes the intensity of the light of either spark to be greater than it would be if the other one did not exist—in a particular case the light of the shorter was increased six or eightfold—at the same time the duration is not greatly affected. For this reason the spark at E may be made very short, so that the shadow is almost as sharp as if the light came from a point. The spark formed at B, which is due to the discharge of *c* only, is very feeble, so that it is unable to act on the plate, whereas, had the discharge of C been carried round by B, the light at this point would hopelessly have spoilt the plate, and at the same time the light at E would have been feebler and would have lasted longer.

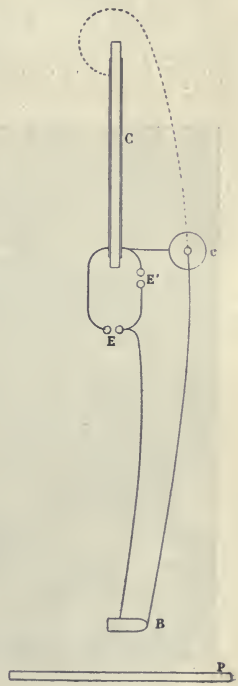


Fig. 4.

[1] These sparks were made to go off at the time that the mirror was facing towards the photographic plate by the employment of the same device as that described below in connection with Fig. 4. On the axle of the mirror an insulated tail of aluminium was secured, so as nearly to bridge a gap in the discharge circuit of an auxiliary jar of small capacity, there being a gap common to both circuits. A self-induction coil was used instead of the wet string, as being for this purpose preferable. The length of time that the spark lasted was thus measured without taking the electricity round by the mirror, which would have been quite sufficient to modify the duration of the discharge, and it was easier than making and adjusting a second reflecting mirror, which would have answered the same purpose.

[2] See Nature, vol. xlii. p. 250.

The wet string, while it is for the purpose of keeping the condenser c charged a perfect conductor, is nevertheless, when this discharges at E′ and B, practically a perfect insulator; if it were replaced by wire then C would also wholly or partially discharge itself by B and E′. Finally, in avoiding all lenses one is free from the considerable absorption of the more refrangible rays which sparks provide in great abundance, and which are largely absorbed by glass. On the other hand the photograph is a mere shadow, but this is no drawback, for the bullet itself is on either system a mere silhouette, whereas the atmospheric phenomena are more sharply defined, and their character is more clearly indicated without lenses than is possible when they are employed.

Fig. 5 is a photograph of the apparatus set up in one of the passages in the Royal College of Science, in which the experiments were made. It is apparently of the rudest possible construction. The rifle seen on the left of the figure is of course made to rest freely on six points,[1] in order that its position every time it is fired may be the same. The bullet then traverses precisely the same course, so that wires placed in the line between holes in two cards made by one shot will be hit by the next. The two wires which the bullet joins as it passes by are set up in the box seen in the middle of the figure with the lid propped up so as to show the interior. The photographic plate is on the left-hand side and the spark when made is just within the rectangular prolongation on the right-hand side. Paper tubes with paper ends are placed on each side of the box to allow the bullet to enter and leave, and yet not permit any daylight to fall directly on the plate. All is black inside, and so the small amount of light which does enter the box through these holes is not diffused in any harmful manner. The large box at the back is a case 5 ft. long, filled with bran which stops the bullets gently without marking them. The little condenser is just below the rectangular prolongation of the photographic box, the large condenser is the vertical square sheet seen just to the right. The electrical machine used to charge the condensers is seen on the table. It is a very beautiful 12-plate Wimshurst machine made by Mr. Wimshurst and presented to the Physical Laboratory. This machine not only works with certainty but is so regular in its working that no electrometric apparatus is necessary. All that has to be done is to count the number of turns of the handle which are required to produce the sparks at E and E′ when the gap at B is not joined, and to count the number which are sufficient to produce a spark at E when the gap at B is suddenly closed. Then if the rifle is fired after any number of turns between these, but by preference nearer the larger than the smaller number, the potential will be right, the spark E, inside the box, and the spark E′, which is in sight outside the box, will be let off, and if a plate is exposed a photograph will be taken. If by chance the E′ spark is not seen then there is no occasion to waste the plate, another bullet may be fired after resetting the wires and the result will be as good as if one shot had not failed. When all is in order a failure of this kind is very rare. I also arranged a tube in the side of the box with a pocket telescope fixed in it and focussed on the wires. If a piece of white card or paper is placed in the line of vision and so as to be illuminated by a spark let off as above described but preferably much nearer the card, the bullet will be seen by any one looking through the telescope. I took this down, however, at once, as the photograph showed more than could ever be seen by the eye. The box seen just to the right of the rifle with a coil of wire upon it is the one in which the revolving mirror was fixed, and in which the trails of sparks made near the door at the end of the passage were photographed. The apparatus for photographing

FIG. 5.

[1] Six independent points of support are required for a geometrical clamp. In this case a V support near the muzzle supplied two, a V support near the breach two more points, the rifle was pressed forward until a projection under the muzzle rested against the front V, thus allowing freedom of recoil, but otherwise preventing all uncertainty of position except that due to rotation in the V's which is made impossible by the sixth point, that is, the lower end of the stock resting sideways against a leather covered wooden bracket fastened to the same table to which the V's were attached.

the bullets was put together and set up by Mr. Barton, a student, whose very skilful help in the matter and afterwards during the experiments I found of very great value.

FIG. 6.

was put together. It was taken to see if the idea would practically succeed, merely using for the purpose bits of wire and other things to be found in any laboratory, which were set up in a dark room in less than an hour. The first shot was successful, but the sharpness of the photograph is not what it might be, owing to the fact that I used, for the sake of the brilliant light, a spark taken between magnesium terminals. However, the bullet is clearly enough defined, as are the wires which it has just struck. This is a photograph of a pistol bullet travelling only 750 feet a second. You will notice that unlike that taken by Prof. Mach, which represented a shot going at a much higher speed, this photograph shows no atmospheric phenomena surrounding the bullet. I would only add, in connection with this photograph, that by some accident the wad remained attached to the bullet in this case forming the enlarged tail. I do not know if this often happens; it must, if it does, seriously disturb the flight of the projectile, and introduce an anomaly that might not easily be accounted for.

The next photograph, Fig. 6, shows a bullet which has just left a Martini-Henry rifle. This is taken with the apparatus in its latest form, and the bullet appears perfectly sharp. There is no sign of any movement whatever in so far as the bullet itself is concerned.

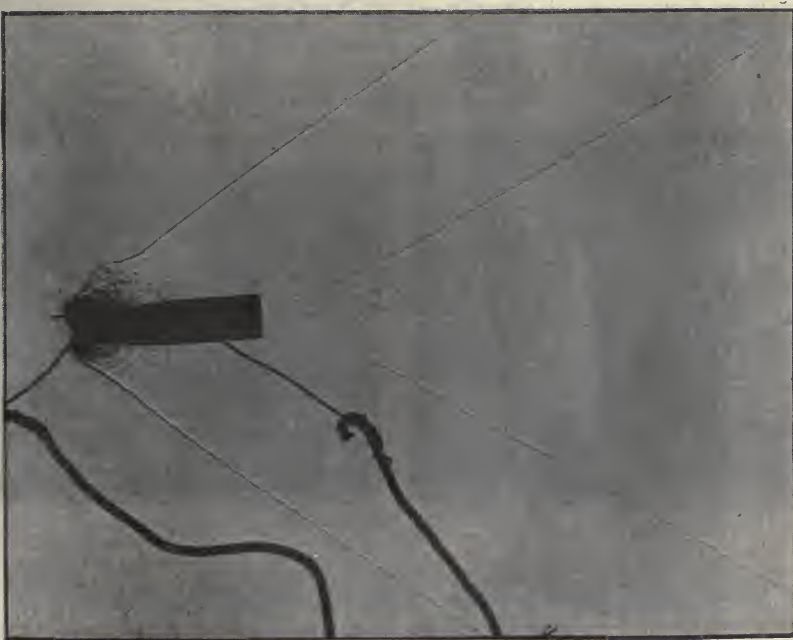


FIG. 7.

The first photograph which I am able to show was taken at Christmas, before the apparatus just described

But now that we are dealing with a higher speed, namely, 1295 feet a second, there is evidence of the movement of the bullet in the form of a wave of compressed air in front and of other waves at the side of and behind the bullet. I shall explain this in a moment, but I would rather first show another photograph, Fig. 7, of a bullet travelling at a still higher speed, a magazine rifle bullet travelling about 2000 feet a second, in which these air waves are still more conspicuous, and in which a glance is sufficient to make it evident that the waves are much more inclined to the vertical than in the previous case.

Now as it may not be evident why these waves of air are formed, why their inclination varies with the speed, or why existing they are visible at all, a short explanation may not be out of place, more especially as they form the most interesting feature in the remaining photographs that I have to exhibit, which cannot, as a matter of fact, be properly interpreted without frequent reference to them.

I would first ask you to examine some still water into which a needle held vertically is allowed to dip. If you move the needle very slowly not a ripple is formed on the surface of the water; but as the needle is moved more quickly at first a speed is reached at which feeble waves appear, and then as the speed increases a swallow-tail pattern appears, the angle between the two tails become less as the velocity gets higher. Now in the case of water-waves the velocity with which they travel depends on the distance between one and the next, and for a reason into which I must not now enter either very long or very short waves travel more quickly than waves of moderate dimensions. If they are about two-thirds of an inch long they travel most slowly—about 9 inches a second. Now so long as the needle is travelling less quickly than this no disturbance is made; but when this speed is exceeded the swallow-tail appears. Suppose, for example, the velocity of the needle to be double the minimum wave velocity for water, *i.e.* let the needle move at 18 inches a second, and let it at any moment have arrived at the point *p*, Fig. 8. Then any disturbance, started

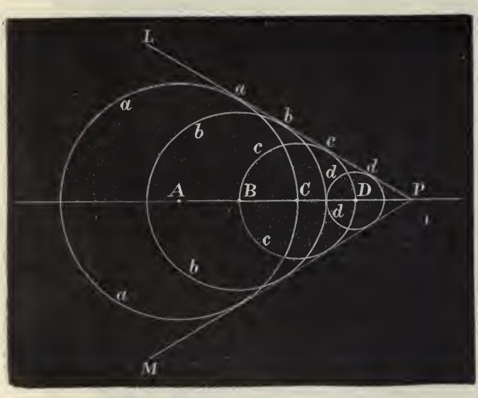


FIG. 8.

when it was at the point A, must have travelled as far as the circle *aaa* in which A*a* is half A*p*, similarly for any number of points BC, &c., between A and *p* any disturbance must have travelled as far as the corresponding circles *bb*, *cc*, &c., the result is that along a pair of lines, *p*L, *p*M, touching all the circles that could be drawn in this way, a wave will be found, and it is clear that as the velocity of the point is made greater the successive radii A*a* B*b*, &c., will become in proportion to A*p* less, the circles will be smaller, and the angle between L*p* and M*p* will become less, while when the velocity is made less the reverse happens, until at last A*a* B*b*, &c. = A*p* B*p*, &c., and then when they exceed these quantities no lines L*p* M*p* can be drawn touching all these circles, there is no wave surface which the disturbances from all the successive points can conspire to produce, and the consequence is there is still water.

Now consider the case of a bullet moving through the air. Here again we are dealing with a case in which a wave cannot travel at less than a certain speed which is obviously the velocity of sound (1100 feet a second under ordinary circumstances), but, as in the case of surface waves on water, higher speeds are possible when the wave is one of very great intensity. The conditions in the two cases are therefore very nearly parallel; if the bullet is travelling at less than the minimum speed no waves should be formed—the pistol bullet at 750 feet a second did not show any—if the bullet is travelling at higher speeds than 1100 feet a second waves should be formed which should include a sharper angle as the speed is made to increase. This was found to be so in the case of the Martini-Henry and the magazine rifle bullet.

The curved form of the wave near the apex is due to the fact that when it is very intense, when the compression is very great, the velocity of travel is greater and, immediately in front of the bullet, the air is compressed to so great an exent that the wave at this part can travel at the speed of the bullet itself.

The reason why the waves should be visible at all is not difficult to follow. Consider a shell of compressed air though which rays of light from a point are made to traverse. These rays travel in straight lines, except where they meet a medium of different density, and the denser this is and the more nearly they meet this at a grazing incidence the more they will be bent towards the perpendicular. In comparison with water or glass a layer of compressed air has very little refractive power, and so rays which strike the shell anywhere except at the extreme edge are practically uninfluenced in their course and strike the plate practically in the same place that they would do if the shell of compressed air had not been

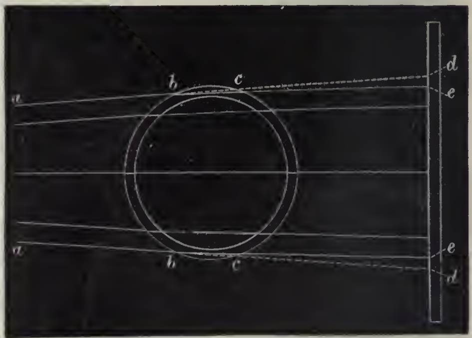


FIG. 9.

traversed. But those rays *ab*, *ab*, Fig. 9, which strike the shell of air almost tangentially are bent inwards slightly at *b* and again at *c*, having traversed what is equivalent to a wide angle prism, and strike the plate at *e*, leaving the place *d*, where they would have gone had they not been refracted, dark; moreover at *e* they meet other rays which have been hardly at all refracted since they have passed actually into the shell and out again, and therefore *e* is doubly illuminated. The consequence is that a wave or shell of

compressed air gives rise to an image on the plate, in which there is a dark line and a light line within it. Similarly a wave of rarefaction must produce a light line with a dark one within it.[1] An examination of the photograph Fig. 7 will make it evident that not only is the head wave a wave of compression, but the wave, which starts from the end of a kind of vena contracta behind the bullet, is also a wave of compression. It is a curious fact which requires explanation that the head and tail waves are not parallel to one another, and they do not show any sign that they would become parallel if they were continued indefinitely. This can only be due to either the tail of the bullet travelling considerably faster than the head, or to the actual velocity of propagation of the tail wave being less than that of the head wave. The effect observed is true and is not optical, being neither due to the refractive effect of the outer shell disturbing rays which are tangential to the inner shell, nor to an effect of perspective, for though the projection of a cone from a point upon a plane is only seen of the proper angle, when the perpendicular, dropped from the point upon the plane, passes through the vertex of the cone, yet when, as in the case of Fig. 11, where it passes within both cones, and more within the outer one than the inner one, the effect is to make the projections of both of a greater obtuseness, and of the outer one to a greater extent than the inner one; nevertheless an examination of the amount of this effect of perspective made by Mr. Barton showed that the distortion was not sufficient to be noticeable, as the difference in the acuteness of the cones certainly is.

(*To be continued.*)

NOTES.

ADMISSION to the Croonian Lecture, which Prof. Virchow, as we have already announced, is to deliver before the Royal Society at 4.30 p.m. on the 16th inst., will be by ticket, which may be obtained from the assistant secretary by introduction of a Fellow of the Society.

THERE will be widespread regret at the announcement which we now make that the distinguished geologist, Prof. K. A. Lossen, of Berlin, died there on the 24th ult. He had been ailing for some time, and suffered severely before he entered into his rest. In spite of the deafness which necessarily restricted his intercourse with men of science, he had formed a wide circle of friends who learned to appreciate the simplicity, candour, and geniality of his character, while at the same time they came to respect and admire more and more his wide range of knowledge, and that marvellous and apparently intuitive perception of the true characters of rocks which made him probably the best field-petrographer in Germany.

WE have received news of the death of Cav. Giuseppe Antonio Pasquale, for many years professor of botany in the University of Naples, and director of the botanic garden. Prof. Pasquale was the author of numerous articles on botany and cognate subjects. His earliest works of which we have cognisance were on the flora of Capri (1840), and the flora of Vesuvius (1842). In 1869 he published a more complete "Flora Vesuviana, confronte con quella dell' isola di Capri." He appears to have been appointed to the post of director of the Naples Botanic Garden in 1866, and the following year he published a catalogue of the plants cultivated there, together with a brief history of the garden.

THE German Government has established a biological Institute on the island of Heligoland, and has appointed Dr. Kuckuck its botanical director.

PROF. SCHWEINFURTH landed at Port Said on January 7, for an expedition into Upper Egypt which is intended to extend over several months. Dr. D. Riva, who accompanied Schweinfurth on his last journey, has undertaken an expedition to Eastern Africa in the vicinity of the river Giuba.

THE moss-herbarium of Dr. Rehmann and the Hepaticæ-herbarium of Dr. Gottsche have passed into the possession of the Botanical Museum of Berlin; the Botanical Museum of the University of Vienna has acquired the moss-herbarium of Hoppe; and the Botanical Institute of the German University at Prague the greater part of the valuable library of Prof. Willkomm.

THE Reale Instituto Veneto di Scienze, lettere ed arti proposes the following prize subjects:—(1) A lithological, mineralogical, and chemical investigation of the rocky, sandy, earthy and saline materials brought down under various conditions by one of the chief rivers of Venetia from the Alpine valleys, and deposited at various distances from the base of the Alps to the sea (prize, 3000 lire, date December 31, 1893). (2) A compendium of the history of mathematics, with a mathematical chrestomathy containing extracts from mathematical works of antiquity, the middle ages, the renaissance, and recent times down to Gauss (indicating in each case the reason for introducing the extracts), prize and date the same. Papers may be written in Italian, Latin, French, German, or English, and are to be sent in to the secretary with motto and sealed packet.

SIR ANDREW BARCLAY WALKER, who died on Monday, did much to promote intellectual life in Liverpool. The University College of that city has good reason to remember him as one of its most generous benefactors. He assumed the entire pecuniary responsibility for the erection of the Walker engineering laboratories, which cost about £20,000.

MR. O. M. EDWARDS, who was appointed to investigate the various conditions which have to be taken into account in connection with the proposal for the establishment of a Welsh University, has completed his inquiries and forwarded his report to the Vice-President of the Committee of Council on Education. A writer in the *University Correspondent* says the report is practically a pamphlet of about eighteen octavo pages, containing a short account of the origin and progress of the educational movement in Wales, and intended to supplement the information already possessed by the Department of Education on this head. It contains a succinct epitome of the various schemes proposed—the Shrewsbury Charter, the proposals of Dr. Roberts and Prof. Evans; gives the state of efficiency of Lampeter and the three Welsh colleges; contrasts them with those at Leeds and Manchester; and points out how far, more or less, the Welsh institutions are prepared and adapted, in point of staff, students, accommodation, and appliances, to receive similar powers.

THE Municipal Council of Paris has been giving names to some new streets, and changing those by which various old streets have hitherto been known. The names selected for use are for the most part those of illustrious Frenchmen, and it is significant that among them are some well-known men of science. The Rue du Battoir, for instance, is henceforth to be called the Rue Quatrefages, in memory of the famous anthropologist; and the Rue Claude-Vellefaux becomes the Rue Charles-Robin, in memory of the great physician. A new street is called after

[1] It may be worth while to point out that the dark and light lines are, and ought to be, parallel to one another as soon as they are so far away from the shadow of the bullet as to be practically straight lines. For if the thickness of the shell is divided up into a series of elements the ray passing through any one of these will meet with a refractive medium, which is less effective as the diameter of the part of the shell considered is greater, while the refractive angles of the elementary prisms become inclined more so as to compensate for the diminished density.

Ernest Renan. This is only one of many indications of the respect in which science is held in France. We shall probably have to wait some time before it is decided by the municipal authorities of London that streets shall be known by the names, say, of Darwin and Joule.

The atmospheric disturbance referred to in our last issue as crossing this country on Tuesday, February 21, reached the English Channel on the following day; afterwards its progress eastwards was unusually slow, and north-west winds belonging to the rear of the disturbance were experienced. Frost occurred during the night of the 22nd in many parts, and towards the close of last week the daily maxima fell below 40°, except in the extreme west and south-west, while in the midland counties frost continued throughout the day, and hail and snow occurred in many places. After a temporary improvement in the south and south-east districts on Saturday, a deep depression reached our south-west coasts from the Atlantic, causing strong gales on Sunday, and very severe snowstorms in Scotland, with heavy rain in other parts of the country, the fall exceeding an inch and a quarter on the north-east coast. By Sunday evening the disturbance had reached the north-east of England, where the barometer had fallen to 28·6 inches; this depression was preceded by severe frost in Scotland, the minimum temperature recorded at Nairn being as low as 11°. On Monday a north-westerly gale was blowing in Scotland, accompanied by snow, and on the same day a new depression arrived over the south-west of England, accompanied with further heavy rainfall in the southern half of the kingdom, and strong winds and gales in the English Channel; frost also occurred in many parts. After these gales had subsided, the weather still remained in a very disturbed and unsettled condition. The *Weekly Weather Report* issued on February 25 showed that the temperature for that week was generally 1° to 2° below the mean in Great Britain, and 3° to 4° below in Ireland; also that the rainfall was much in excess of the average in the southern and eastern parts of England.

The Report of the Meteorological Council for the year ending March 31, 1892, just presented to Parliament, reviews the work of the office under four heads: (1) *Ocean Meteorology*. The charts for the Red Sea were in an advanced state, and the extraction of data for the current charts of the Atlantic, Pacific, and Indian Oceans, and of data referring to the southern ocean, was being actively carried on. In this branch of the work the supply of instruments to ships is supplemented by the supplies to remote stations, when favourable opportunities occur. (2) *Weather Telegraphy and Forecasts*. An important station has been established at the North Foreland, and the work generally in this branch continues to increase; both the Daily and Weekly Weather Reports have been extended and improved. Weather forecasts are prepared three times daily; the total percentage of success of the 8h. 30m. p.m. forecasts which appear in the morning newspapers was 80, being 2 lower than in 1890–91. The results were best in England south, and worst in Scotland west. The percentage of success of the forecasts issued during haymaking was 89 per cent. Although these forecasts are issued solely for the benefit of farmers, the Agricultural Department does not at present aid in their dissemination. (3) *Land Meteorology of the British Isles*. Under this head are included all observatories, anemograph stations, and volunteer stations, necessary for the study of the periodic variations of the meteorological elements, and of climatology. Among the publications we may specially mention the "Harmonic Analysis of the Hourly Observations at British Observatories," which is probably the first systematic publication of the description that has hitherto been brought out by any of the established meteorological institutions. (4) *Miscellaneous*. This head gives an account of the various researches now in hand, among which are included investigations relating to rainfall, sunshine, fog, &c. It also contains particulars relating to the work done in cataloguing books and pamphlets, and also a classified summary of expenditure. A special note contains an account of the anemometer comparisons carried out by Mr. W. H. Dines, with the aid of a grant from the Council.

The Meteorological Council have just issued a summary of the *Weekly Weather Report*, 1892, containing, among much other information of importance to agricultural and hygienic meteorology, an appendix showing the rainfall and mean temperature for the 27 years 1866 to 1892, for each of the 12 districts into which the United Kingdom is divided for the purpose of weather forecasts. The values show that the average rainfall for the whole of the British Islands is 34·9 inches; in the wheat-producing districts the average fall for the year is 28·2 inches, while for the grazing, &c., districts it is 41·6 inches. The wettest district is the west of Scotland, where the average annual rainfall is 45·5 inches, and the driest is the east of England, where the average amount is 25·8 inches. The values for the year 1892 varied considerably in different localities; the wettest district during the year was the north of Scotland, where the fall was 5·6 inches in excess of the average, while in the south-west of England the deficiency was 12·5 inches. As regards temperature, the average for the whole area for the 27 years (omitting the Channel Islands) was 48°·4, and the mean difference of temperature between the wheat-producing and grazing districts scarcely amounted to a degree. The average value for the whole area during 1892 was 1°·6 below the mean for the 27 years; there was a deficiency in every district during that year, the greatest amount being 2°·3 in the east of Scotland, and the least, 0°·9 in the south of England; in fact, it was the coldest year experienced since 1879.

An electrical actinometer was used by Messrs. Elster and Geitel, of Wolfenbüttel, in their measurements of the sun's ultraviolet radiation. The instrument, as described in *Wiedemann's Annalen*, was based upon the action of ultraviolet light in accelerating the dissipation of an electric charge from a cathode of amalgamated zinc. By exposing a plate of the metal to the light from a stream of sparks from an induction coil at various distances, and determining the dissipation of a negative charge imparted to it, this was proved to be a linear function of the light intensity. In its portable form the instrument consists of a cylinder which can be directed towards the sun, and into which a charged sphere of amalgamated zinc is introduced by means of an insulating handle. The fall of potential during a few seconds' exposure is determined by means of an Exner electroscope. Messrs. Elster and Geitel have made observations for each month in the year, and found the ultraviolet radiation to exhibit an inverse relation to atmospheric electricity. Comparisons were also made of the results at various heights above the sea-level, the stations being the summit of the Sonnblick (3100 m.), Kolm-Saigurn, in the adjoining valley (1600 m.), and Wolfenbüttel (80 m.). It was found that 40 per cent. of perpendicular ultraviolet rays from space reached the level of Sonnblick, 23 per cent. of these were absorbed before reaching the next station, and only 47 per cent. of the remainder arrived at the level of Wolfenbüttel.

Ten years ago there was some correspondence in Nature on the subject of snow-rollers. The phenomenon does not seem to occur very often, so that some interest attaches to a communication in *Science* (February 3), describing an instance noted last year at Milledgeville, Ohio. Mr. W. S. Ford says that on the morning of January 30, 1892, the clean level fields surrounding that town were covered with balls of snow, varying in size from three to five inches long and from one to two inches wide.

Wheat-fields and meadows abounded with these balls, and suggested, at first sight, that a troop of school-boys had been having a battle with the snow. Two fields, of thirty acres each, that came under Mr. Ford's observation (one a new-sown wheat-field and the other a meadow) were literally covered with these "snow-rollers," there being at least 500 on the acre. Road-sides and lots contained a few, and he noticed them on house-tops and straw-ricks. On close investigation, he found the balls to be uniformly light and fragile, so that to lift one and preserve its form was impossible. Some were oblong, some almost spherical, while others resembled a tea-cup or small bowl. There were no tracks behind them, or, if these had been made, the falling snow had obliterated them. The accompanying weather conditions were as follows:—The ground had been covered with snow for three weeks. A crust had formed on the top, thick and firm enough in places to bear up a person. This thawed a little during the afternoon of the 29th. The ensuing night was warm, the mercury registering 40° F. By ten o'clock a brisk wind was blowing, which increased in velocity, and soon the snow began to fall in large, moist flakes. The morning showed that about a half-inch had fallen on the crust, and on this lay the balls. The phenomenon was reported from several places in the vicinity, chiefly in the Fayette County, and from Clinton County, which adjoins it on the west, but nowhere did the rollers extend uninterruptedly over any great area.

IN November last, according to a writer in the Journal of the Straits Branch of the Royal Asiatic Society, there was in Singapore one of the largest specimens of the Mias or Orang-Utan ever captured; it was a male, and probably of the species known as *Simia satyrus*, Linn., or the Mias Pappan of the Dyaks. The animal was captured in Borneo, and bought by a native dealer in Singapore, who eventually sold him to a German ship's captain, by whom he has been, it is believed, taken to Germany. As far as the writer could judge, his height must have been close on 4 feet 5 inches. The cage in which he was confined was 4 feet 2 inches or thereabouts in height, and he could easily touch the top of it with his head without standing erect. His face was immensely broad, the cheeks being flattened out sideways into a sort of disc. The hair was long (about 4 inches) and thick and of a bright red colour, and he had a distinct short pointed beard. The eyes were dark brown.

A WRITER who signs himself "Tutuila" contributes to the current number of the Journal of the Polynesian Society some interesting notes on the races known as the Tokelaus, or Line Islanders, called by themselves the Kai-n-Abara, which means "people of our land." The Kai-n-Abara inhabit all the islands of the Gilbert Group, Nanumea, and Nanumanga in the Ellice Group, and Banapa or Ocean Island. They are apparently of the Micronesian type, but although they have long straight hair, and are more of a copper colour than brown, they are not pure Micronesian. They are intelligent, can reason inductively, are brave, having a very respectable share of courage, and are extremely pugnacious, both sexes fighting like fiends on the least provocation. In every township there is a large house called "maneabau," in which the members of each family of "aomata" or "gentry" have a certain space allotted to them. All the social government is carried on in this house, and everything of a public nature is discussed in it. Decision is given by general vote, the majority carrying their point. The older and wealthier landowners have most influence where there are no nobles, but do not seem to have more votes than any one else. A woman can vote and speak as well as a man, and in general the women decide the question, unless it is one of war against another island.

MR. A. J. CHITTY records in the new number of the *Entomologist's Monthly Magazine* that in the neighbourhood of Forres, Morayshire, where he spent six weeks last autumn, he found that Coleoptera were very abundant. He captured specimens of a good many species new to the district, and one or two which had not, he believes, been recorded before from Scotland.

A LIST of the Batrachia in the Indian Museum, by W. L. Sclater, has been issued by the trustees of the institution. The arrangement and nomenclature are formed on Mr. Boulenger's work in the British Museum catalogues, and the Reptiles and Batrachia in the "Fauna of British India" series.

AN interesting paper on the were-wolf in Latin literature, by Kirby W. Smith, is printed in the new number of the Johns Hopkins University Circulars. The were-wolf is a person who, either from a gift inborn or from the proper use of certain magic arts of which he has learned the secret, can change himself into a wolf of unusual size and ferocity; or, furthermore, the transformation may be unavoidable, owing to the curse or charm of some outside power, and not to be got rid of until a fixed period has elapsed or various conditions, more or less difficult, have been complied with. Such enchantments are common in the folk-lore of all nations, but, on Roman ground, they do not appear in connection with the were-wolf story. Mr. Smith mentions the were-wolf story told by Petronius, who describes how the companion of the freedman Niceros took off his clothes, and, becoming a wolf, began to howl and took to the woods. Niceros tried to pick up the clothes, but found they had all turned to stone. The wolf was wounded in the neck with a spear, and afterwards Niceros found his comrade in bed, while his neck was being dressed by a doctor. Here the transformation is attributed to a power born in the person, and Mr. Smith thinks that this may be the nearest approach to the original form of the superstition, because "among savages, these modern types of early humanity, just such stories are more or less common." The other class of Roman were-wolf stories—those in which the change is effected by means of a charm—simply form one of a large number of different transformations, the theory and methods of all being practically the same.

WE have received the first part of the new *Contributions from the Botanical Laboratory of the University of Pennsylvania*. It contains papers by Dr. J. T. Rothrock on a monstrous specimen of *Rudbeckia hirta*, and on a nascent variety of *Brunella vulgaris*; by Dr. J. M. Macfarlane, contributions to the history of *Dionæa muscipula*; by Mr. J. W. Harshberger on an abnormal development of the inflorescence of Dionæa; by Mr. H. Trimble on Mangrove tannin; by Dr. W. P. Wilson on *Epigæa repens*, and on the movements of the leaves of *Melilotus alba*.

THE paper by Dr. Macfarlane on Dionæa is of great interest and confirms the statement previously made by him that, to produce closure of the leaf, two distinct stimuli are required, which may be communicated to the same hair, or to different hairs on the same half, or to hairs on opposite halves of the leaf. He regards the leaf, previous to secretion, as in a state of tetanic contraction, resulting from a series of stimuli, which may either be partially or entirely mechanical, thermal, luminous, chemical, or electric. The so-called "hairs" are not true hairs, but emergences, and their structure is described in detail. Each consists of three distinct regions, the joint, the base, and the shaft. While previous observations, such as those of Darwin and Prof. Burdon Sanderson, have been made on plants of Dionæa under abnormal conditions of cultivation, Macfarlane's are especially valuable as having been made on the plant in its native condition; and this is also the case with those of Mr. Bashford Dean, contributed to the Transactions of the New York Academy of

Sciences. Mr. Dean states that there is a marked difference in the irritability of different leaves; that the leaves usually fail in capturing the larger and more active insects; that even small insects constantly escape; and that the leaf repeatedly closes on inorganic and vegetable objects.

MR. W. SAVILLE-KENT'S book on "The Great Barrier Reef of Australia" will be ready for publication before the end of the present month. It will include a series of photographic views of coral reefs of various construction from several selected localities, with similar and also coloured illustrations and descriptions of the living corolla, coral-polyps, and other marine organisms commonly associated on the reefs. Meanwhile, Messrs. W. H. Allen and Co., who are to publish the book, have issued enlarged and very beautiful copies of some of the principal illustrations. These are intended for the use of museums, colleges, and natural history societies, and will certainly be highly appreciated wherever they may happen to be introduced.

A TRANSLATION of Prof. Weismann's "Das Keimplasma," recently reviewed in NATURE, has been issued in "The Contemporary Science Series" (Walter Scott). The translators are Prof. W. N. Parker and Harriet Rönnfeldt, who have done their work carefully. In the preface Prof. Parker explains that in the case of special technical terms which have no recognised English equivalents he has added the German words in brackets the first time they are used. He has had the great advantage of being able to consult Prof. Weismann personally with regard to many of the more difficult passages.

THE County Council of Northumberland has issued a valuable pamphlet, by Dr. W. Somerville, giving an account of experiments made last season throughout Northumberland with a view of gaining practical information regarding some points connected with the economic manuring of the turnip crop.

MESSRS. METHUEN AND CO. have added to their "University Extension Series" a volume on "The Mechanics of Daily Life," by V. P. Sells. The author makes no attempt at the mathematical treatment generally adopted, but seeks rather to use the subject "as a means of scientific training, and as an illustration of the method of examining nature by reasoning and experiment."

MESSRS. CASSELL AND CO. are publishing in monthly parts a new issue of Dr. Robert Brown's "Our Earth and its Story," with many coloured plates, maps, and upwards of 700 illustrations.

TWO important papers upon the ready preparation of large quantities of the more refractory metals by means of the electric furnace are contributed by M. Moissan to the current number of the *Comptes Rendus*. The "electric furnace" is simply a small furnace constructed of lime, so arranged that it can be intensely heated by a very powerful electric arc. A quantity of magnesia, which M. Moissan finds to be perfectly stable even at this high temperature, is first placed in the cavity of the furnace, and upon this the crucible of retort-carbon containing a mixture of powdered carbon and the metallic oxide to be reduced. When the metal is volatile a current of hydrogen is passed through the furnace, and the vaporised metal is condensed in a comparatively cool receiver. In this manner M. Moissan has succeeded in rapidly preparing considerable quantities of the metals of the alkaline earths, calcium, strontium, and barium. If the metal is not sensibly volatile it is left in the crucible after the reduction in the form of an ingot. The rare metal uranium, and the metals manganese and chromium belong to this category, and their preparation forms the subject of M. Moissan's two communications.

METALLIC uranium was prepared with great difficulty, and only in small quantities by Peligot, by reducing the oxide with an alkali metal. At ordinarily procurable temperatures the various oxides of uranium are practically irreducible by carbon. This no longer obtains, however, at the extremely high temperature of a very powerful electric arc. The nitrate of uranium is first calcined in a porcelain crucible, whereby a reddish-coloured mixture of the sesquioxide and of the green oxide U_3O_4 is obtained. This mixed oxide is then well ground with a very slight excess of powdered carbon, and the whole tightly packed in the crucible of retort-carbon, which is afterwards placed in position in the lime furnace. Upon submitting the mixture in the crucible to the action of the arc produced by a current of 450 ampères, the reduction is completely effected in a few minutes. The ingot of uranium thus produced exhibits a brilliant fracture and great hardness. It possesses the peculiar property of sending forth a shower of incandescent sparks when struck against a piece of porcelain, or when fragments of it are shaken about in a glass flask, reminding one of the combustion of particles of freshly-reduced iron when allowed to fall through the air. The yield of the metal is very considerable; thus in one experiment of twelve minutes' duration an ingot weighing over two hundred grams was produced. The metal is not quite free from carbon, the amount of the latter depending upon the excess used. M. Moissan is now engaged in perfecting a ready mode of refining it.

IN order to prepare metallic manganese the protoxide is mixed with carbon as in the case of uranium, and the mixture submitted to the arc produced by a current of 300 ampères. The reduction is completely effected in five or six minutes, an ingot of 120 grams being readily obtained. The comparatively weaker arc derived from a current of only 100 ampères gives the same yield in 10–15 minutes. Any large excess of carbon is to be avoided as carbides of manganese are then produced. If an excess of the oxide is employed the metallic manganese obtained is almost pure, and may be preserved unchanged in open vessels. The carbides, however, are rapidly attacked by the moisture of the atmosphere, and if thrown into water evolve a gaseous mixture of hydrogen and various hydrocarbons. Chromium has always been found hitherto to be much more difficult to reduce than manganese, but complete reduction occurs in 8–10 minutes in the electric furnace, employing a mixture of the sesquioxide and carbon and a current of 350 ampères, the yield being an ingot of 100 grams. A current of only 30 ampères, however, is sufficient to produce ten grams of the metal in half an hour's time. Moreover, it is possible to refine the somewhat impure (from carbide) metal by a simple repetition of the process in presence of a fresh quantity of the sesquioxide. The pure chromium thus obtained is completely transformed into the volatile chloride when heated in a stream of chlorine. The reduction in the electric arc succeeds equally well with crude chrome iron ore, an alloy of iron and chromium being obtained from which the chromium may very readily be converted into chromate by projecting it into fused nitrate of potash or soda and subsequent extraction with water.

NOTES from the Marine Biological Station, Plymouth.—During the past week ephyræ of *Aurelia* have become quite plentiful in the Sound. The Anthomedusæ have been represented by numbers of the charming *Rathkea octopunctata* of Haeckel; and the Leptomedusæ (which are still scarce) by isolated examples of several species, including the *Thaumantias octona* of Forbes. Ctenophore ova and several larval and young Ctenophores have been noticed. The proportion of Polychæte larvæ and of Cirrhipede *Nauplii* remains fairly constant; while there has been an appreciable increase in the numbers of Brachyurous Zoœæ. The Hydroid *Sertularia argentea* and Actinian *Cereus pedunculatus* (=*Sagartia bellis*) are now breeding.

THE additions to the Zoological Society's Gardens during the past week include a Mozambique Monkey (*Cercopithecus pygerythrus*, ♂) from East Africa, presented by Mr. R. Hughes; a Bonnet Monkey (*Macacus sinicus*, ♀) from India, presented by Mr. W. Yeoman; two Herring Gulls (*Larus argentatus*) British, presented by Mr. J. S. Williams; an Ariel Toucan (*Ramphastos ariel*) from Brazil, presented by Mr. Ellis Edwards; a Great Eagle Owl (*Bubo maximus*) European, presented by Commander E. G. Rason, R.N.; two Spengler's Terrapins (*Nicoria spengleri*) from Okinawa Shima, Loo Choo Islands, presented by Mr. P. Aug. Holst; two Tuatera Lizards (*Sphenodon punctatus*) from New Zealand, presented by Capt. Worster; a Spiny-tailed Mastigure (*Uromastix acanthinurus*) from Algeria, presented by Miss Rigley; a Cuming's Octodon (*Octodon cumingi*) from Chili, deposited; an Eland (*Oreas canna*, ♂), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET BROOKS (NOVEMBER 19, 1892).—The following ephemeris has been computed by Ristenpart (*Astronomischen Nachrichten*, 3154) from five normal places of this comet, using the elements—

T = 1893, January 6·529304 M.T. Berlin.

$$\left.\begin{aligned} \omega &= 85^\circ\ 12'\ 51''\!\cdot\!0 \\ \Omega &= 185\ 36\ 29\cdot0 \\ i &= 143\ 51\ 45\cdot9 \end{aligned}\right\} 1890\cdot0$$

$$\log q = 0\cdot0774148$$

12h. Berlin M.T.

1893.	R A. (app.) h. m. s.	Decl. (app.) ° ′	Log r.	Log Δ	Br.
Mar. 2	0 39 35	+22 18·6			
3	40 37	22 4·1			
4	41 37	21 50·1			
5	42 37	21 36·5	0·1738	0·3379	0·54
6	43 36	21 23·3			
7	44 34	21 10·5			
8	45 31	20 58·1			
9	0 46 27	20 46·1	0·1842	0·3563	0·47

The unit of brightness occurred on November 21·5, 1892.

COMET HOLMES (1892, III.).—M. Schulhof, in *Astronomischen Nachrichten*, No. 3153, continues the ephemeris for Comet Holmes, from which we make the following extract:—

12h. Paris Mean Time.

1893.	R.A. (app.) h. m. s.	Decl. (app.) ° ′ ″
March 2	2 30 59·8	+34 49 0
3	32 42·7	51 41
4	34 26·0	54 24
5	36 9·6	57 7
6	37 53·5	34 59 52
7	39 37·7	35 2 37
8	41 22·2	5 24
9	43 7·1	35 8 11

NOVA AURIGÆ.—Last week we mentioned that Mr. Fowler's observation of this nova consisted of two bright nebula lines situated near wave-lengths 5006 and 4956, the former being only slightly brighter than the latter. In *Astronomischen Nachrichten*, No. 3153, Mr Huggins, in a note dated February 11, writes with respect to his observations on February 7, 8, and 10, using a 4-inch Rowland grating (14,438 lines to the inch) and the second order, that the band was "resolved into a long group of lines extending through about 15 tenth-metres. The lines appeared more or less bright upon a faintly luminous background which could be traced a little beyond the lines at both ends of the group. Two lines, the brightest in the group and about equally bright, formed the termination of the group towards the blue; and a line nearly as bright as these was seen about the middle of the group. The group is therefore brighter at the blue end, but it does not possess any of the features of a fluting. No contrast in the spectroscope could well be more striking than that which this extended group of lines forms with the narrow and defined principal line in the nebula of Orion."

HYDROGEN LINE Hβ IN THE SPECTRUM OF NOVA AURIGÆ. —Owing to the curious appearance of the Hβ line in the spectrum of Nova Aurigæ, this line first appearing double and then afterwards quadruple, various explanations have been put forward to account for this peculiarity. From the hypothesis of two bodies, which did not agree with the facts observed, that of three and more bodies was suggested, until at last it was supposed that six bodies in all were in question. This supposition seemed most improbable, and since then the matter has been allowed to lie dormant. With reference to the behaviour of this line in the spectrum of vacuum tubes, Herr Victor Schumann (*Astronomy and Astrophysics* for February) has made some very interesting experiments, taking great care to use the hydrogen in as dry and pure a state as possible. We will here only refer to the most important part of the paper, leaving the reader to refer to the article itself for the apparatus, &c., employed. The photographic plates employed were made by himself according to the "silveroxydammonmethode" of Dr. Eder, of Vienna. Working with pressures from 1 to 100 mm. of mercury, the results obtained at those of 65, 80, and 100 gave the following results:—At 65 mm. Hβ and Hγ were most prominent, and in the negatives they were well defined, "although the sharpness of their edges is injuriously affected by broad, hazy fringes of considerable intensity, which shade off into the background from both sides of the line." Under a pressure of 80 mm. Hβ lost most of its definition, and close to it on each side were observed two fine thin lines, the fringe also being present but a little wider than before. Hγ, although increased in breadth, has lost its definition. With a pressure of 100 mm., "the more refrangible component of the pair of lines just mentioned as belonging to Hβ, has disappeared, and in its place has appeared Hβ itself, broad, but very weak; near by on the lower side one observes a thin line twice." With reference to the fringe of Hβ he says, it has now "spread itself out more towards the blue than the red, thus displacing the middle of it towards the blue." Hγ remains a very weak line. These observations showed that of all the hydrogen lines Hγ was the only one that showed reversal as well as displacement, and he concludes with the remark that "if it be asked whether the phenomena of reversal as observed in my hydrogen spectra furnish in themselves an explanation of the reversal of the lines in the spectra of Nova Aurigæ, the answer must be decidedly in the negative."

COINCIDENCE OF SOLAR AND TERRESTRIAL PHENOMENA.— Since Prof. G. E. Hale commenced his solar researches at the Kenwood Observatory, much has been added by him to our knowledge of the physics of the sun. Faculæ, for instance, which were supposed to be scattered only here and there on the solar surface, are now found, by means of the fine spectroheliograph, to occupy largely both hemispheres, and sometimes to extend in almost unbroken belts across the disc. This fact has led him to consider the question of the probability of chance coincidence between terrestrial magnetism and spots and faculæ (*Astronomy and Astrophysics*, for February), his attention being especially brought in this direction through a paper communicated to the Paris Academy of Sciences by M. Marchaud. M. Marchaud, in summing up his results after an examination of both solar and magnetic observations, says, with reference to the curve of magnetic intensity, that "each of these maxima sensibly coincides with the passage of a group of spots or a group of faculæ at its shortest distance from the centre of the disc." From an examination of 142 photographs of the sun, obtained between January 25 and December 3, 1892, at the Kenwood Observatory, Prof. Hale finds that no less than 132 show "one or more groups of faculæ on the central meridian, *i.e.* at their shortest distances from the centre of the solar disc." The chances, therefore, that at any given time one or more groups may be located at the central meridian, he finds as 0·93. This value, as he remarks, will be reduced for periods of decreased solar activity, but "coincidences noted in epochs like the present can hardly be regarded as of great importance."

"ASTRONOMICAL JOURNAL" PRIZES.—In addition to the prizes already offered, and to which we have previously referred (NATURE, vol. xlvii., Astronomical Column, p. 282), two extra ones, subject to the same conditions, are now to be presented. The first is to be given to "the observer making, by Argelander's method, the best series of determinations of maxima and minima of variable stars during the two years to 1895, March 31." The sum in this case is two hundred dollars. It is stated that "a principal basis for the award is to be the extent to which the de-

terminations will contribute to our better knowledge of the periodic variables by furnishing the largest number of maxima or minima of the largest number of stars, having especial regard to stars whose characteristics are at present not very well known." The award of four hundred dollars will be given for the "most thorough discussion of the rotation of the earth, with reference to the recently discovered variations of latitude." The manuscript (which will be returned to the author) is to be transmitted to some one of the judges not later than March 31, 1895.

For the award of these prizes the judges are Messrs. Asaph Hall, Seth C. Chandler, and Lewis Boss.

GEOGRAPHICAL NOTES.

THE Liverpool Geographical Society has issued its first annual report, which, although not showing a very cordial reception of the new society by the public, is not without some promise of future growth. The Earl of Derby is President, there are twenty-two Vice-Presidents, a substantial Council, and a staff of honorary officials. Staff-Commander E. C. Dubois Phillips has been appointed Secretary. The second year of the society was inaugurated by a lecture on the Discovery of the Alps, by Mr. D. W. Freshfield, President of the Alpine Club, and one of the Secretaries of the Royal Geographical Society. Other lectures have been arranged for, and it is to be hoped that the membership of the society will rapidly increase.

THE tenth German Geographentag is announced to meet in Stuttgart on April 5, 6, and 7. The programme includes (1) The special geography of Würtemberg and the researches on the lake of Constance; (2) Recent geographical investigations with special reference to desert phenomena; (3) Cartography; (4) Economic or applied geography; and (5) School geography. An exhibition will be held at the same time, mainly of objects illustrative of the geography of Würtemberg.

PROF. PENCK has a long paper in the March number of the *Geographical Journal*, describing in detail his scheme for a map of the world on the scale of 1 : 1,000,000. The importance of having maps of every country on one scale has long been recognised by working geographers; but, with the exception of the little atlas on gnomonic projection by the late R. A. Proctor, we do not know of any effort having been made to place such maps before the public. The minute scale of the work referred to reduced its value to a minimum. Prof. Penck's scheme is one of great magnitude. He would allocate the production of the map to the Governments or public bodies of each country. On this principle, 769 sheets would be required to represent the land-surface of the globe, each sheet containing 5° square between the equator and 60°, and between 60° and the poles 5° of latitude and 10° degrees of longitude. The British Empire would be responsible for 222 sheets, Russia for 192, United States for 65, France 55, Scandinavia 54, China 45. Five countries would have from 20 to 30 sheets each, six more would have over 10, and ten countries would require a smaller number, Belgium, Switzerland, and Greece having only one each. One advantage of the proposed scale is that it corresponds within the limits of the shrinkage of paper with the 16 miles to an inch Survey of India maps (1 : 1013760) and with the 25 versts to an inch Russian maps (1 : 1050000).

MONGOLIA AND CENTRAL TIBET.

AT the meeting of the Royal Geographical Society on Monday Mr. W. Woodville Rockhill gave an interesting account of a journey in Mongolia and Central Tibet. Leaving Peking on December 1, 1891, Mr. Rockhill travelled to the frontier town of Kalgan, then, entering Mongolia, he passed through the pasture-lands of the Ch'ahar Mongols. After a few days spent at Kuei-hua Ch'eng, the traveller continued westward, and crossing the Yellow River on the ice at Ho-k'on, he crossed the Ordos Mongols country, and afterwards Alashan. Again entering China proper the route led through Ning-hsia, Lanchou, and Hsi-ning, the westernmost town in China, on the high road to Tibet. On March 14 Mr. Rockhill left for Tibet by an unexplored route, passing south of the Koko nor and along the foot of the mountains to the south side of the Ts'aidam, making several excursions on the way, one of special importance from the Mongol village of Shang to Tosu Nor to determine by astronomical observations the position of this sheet of water discovered by him in 1889. Mr. Rockhill's party consisted originally of five Chinese, but one had to be invalided home a few days after leaving Kumbum, and two others deserted him at Shang. He was able to hire at this place an old Chinese trader, and with these three men, assisted for a while by a Mongol and then by a Tibetan guide, he travelled till he reached China again in October, 1892. On May 27 the final start for Tibet was made from the Naichi gol in western Ts'aidam, and a general south-westerly direction was followed until July 7, when a point some 30 miles from the north-west corner of the great central Tibetan lake, called Tengri nor by the Mongols, was reached. Between the Naichi gol and the Ts'aidam the party had to endure great hardships, the great altitude ranging from 14,000 to 17,000 feet above sea-level, terrible daily snow and hail-storms, fierce winds and frequent absence of fuel, and towards the end starvation. The route, moreover, led them through vast salt marshes, bogs, and across numerous rivers, in which quicksands were frequently found. The geographical results of this portion of the journey were important. (1) The determination of the limits of the basin of the Murus (the great Yang-Tzŭ Kiang of China) and the discovery of the sources of the main branch of this river in the snow-covered flanks of the great central Tibetan range of mountains known as the Dangla. (2) The discovery of the eastern limit of the lake-covered Central Asian plateau which becomes some 600 miles west of the route Mr. Rockhill followed the Pamir, but is in the section he crossed of it called Naktsang, and sometimes, though apparently erroneously, Chang T'ang or "Northern Steppe."

Game was scarce in the great part of this region, and so wild that it could not be approached.

On July 2 the last provisions were eaten, and from that date to the 7th the party subsisted solely on tea. On the latter day a small encampment of Tibetans was reached, and a little food purchased. The next day a valley was entered dotted over with tents; it was the pasture lands of the Namru Tibetans and Lh'asa governed territory. The headman refused to give the party food unless Mr. Rockhill agreed to await the arrival of the head chief, who would decide as to whether he should be allowed to proceed southward, or be sent back to the north.

After six days' discussion with the chief and several officials from Lh'asa a compromise was effected; and Mr. Rockhill, with an escort of ten Tibetan soldiers, started eastward to reach the frontier port of Nagchuká, on the highroad to Lh'asa from the Koko nor.

On July 27 Mr. Rockhill crossed the Dangch'u and found himself on the territory of Jyadé, or "The Chinese Province," which is governed by native chiefs appointed by the Chinese Minister, resident at Lh'asa (or Lh'asa Amban). This important province was separated from Lh'asa by the Chinese in the seventeenth century, in view of the enmity existing between its people, who profess the Bonbo religion, a form of the devil worship or shamanism, though now mixed up with lamaism to such an extent, that it is hardly distinguishable from it, and the followers of the yellow and red sects of Buddhism living on Lh'asa soil.

Passing to the south of the city of Ch'amdo, to which town Mr. Rockhill, like his predecessor, Captain Bower, was refused admittance, the high road to China was reached at Pungdé (two stages south of Ch'amdo), and from this point to China a Chinese escort was given the traveller, and he was able to enjoy (!) all the luxuries of Chinese travel. Stopping at Draya, at Gartok, Bat'ang and Lit'ang, Ta-chien-lu, in Ssŭ-ch'uan, was reached on October 2. Here, on the eastern border of Tibet the journey was practically ended, for, though several thousand miles still separated Mr. Rockhill from the seaboard, they could be travelled in comfort and rapidity. Leaving Ta-chien-lu on October 5, he was in Shangai on the 29th, exactly eleven months from the time he had left it. "In that time I had travelled about 8000 miles, surveyed 3417, and during the geographically important part of the journey crossed sixty-nine passes, all of them rising over 14,000 feet above sea-level, and not a few reached 18,000. I had taken series of sextant observations at a hundred points along the road, determined one hundred and forty-six altitudes by the boiling point of water, taken three hundred photographs, and made important ethno-

logical and botanical collections. For two months we had lived at an altitude of over 15,000 feet, soaked by the rains and blinded by the snow and hail, with little or nothing to eat, and nothing to drink but tea, and yet not one of us had a moment's illness from the day we left till we reached our homes again."

GASES IN LIVING PLANTS.[1]

PLANTS are permeated by the same gases that make up the atmosphere surrounding them: oxygen, carbon dioxide and nitrogen. Nitrogen in the form of a gas is neither used nor generated by any part of plants, unless we except the tubercles of certain roots, and so it occurs in about the same percentage inside the plant as outside of it. On the other hand, both oxygen and carbon dioxide enter into combination with, and are liberated from, the plant tissues in varying amounts at different times. The percentage of these two gases in the cavities of the plant vary through a considerable range. In a series of determinations made by Lawes, Gilbert, and Pugh, in England, the oxygen ranged from 3 to 10 per cent., and the carbon dioxide from 14 to 21 per cent. in plants which had been for some time in the dark, while plants which had been standing in sunlight reversed these figures, and gave 24 to 27 per cent. of oxygen and 3 to 6 per cent. of carbon dioxide. The two gases, therefore, bear a somewhat reciprocal relation, their sum usually being about 25 to 30 per cent. of the total gas in the plant.

The variations in the relative amount of oxygen and carbon dioxide are due to two independent processes incident to the life of plants. One of these processes is assimilation, by which all green cells of plants in the presence of sunlight, or its equivalent, such as a strong electric light, absorb carbon dioxide and liberate oxygen. This process goes on with great rapidity in healthy cells, but is entirely checked upon the withdrawal of light, or when it reaches a certain low intensity. Of course it never takes place in roots, flowers, the central portion of large stems, or other parts which are not green, nor in any fungi or other plants not possessed of green colouring matter.

The other great cause of disturbance in the relation of oxygen and carbon dioxide in the plant is the process of respiration.

Respiration in plants is essentially the same as in animals, and consists in a fixation of oxygen and the liberation of carbon dioxide. It takes place in every living cell, whatever the kind of plant, whatever the part of the plant, and whatever the conditions of active existence. The rate of respiration varies with the temperature, the age of the cell, and the nature of the chemical transformations. In normal respiration the amount of oxygen absorbed is approximately the same as the amount of carbon dioxide evolved. There are, however, certain modified forms of respiration in which this does not hold true.

If living plants be placed in a vacuum, or in an atmosphere deprived of oxygen, it is found that they can still carry on life processes for some time, accompanied with an evolution of carbon dioxide. The oxygen necessary for this process is obtained from the breaking up of compounds in the cells, and it is therefore called intramolecular breathing.

The germination of seeds, which contain a large amount of oil, is somewhat the opposite of this last process. In order to convert the fat into a more directly serviceable food material for the plant, a large amount of oxygen enters into the new combination, for which there is no equivalent amount of gas liberated. It consequently comes about that oily seeds in germinating absorb a far larger amount of oxygen than they liberate of carbon dioxide. This is known as vincular breathing.

Another variation from normal respiration is known as insolar breathing, and which, with still some other modifications, I need not stop to explain. To this brief statement of plant respiration must be added that much yet remains to be discovered regarding the details of the processes.

Assimilation and respiration are the two great causes which disturb the relative volume of the two variable gases in plants.

We shall now turn to the movement of the same two gases, oxygen and carbon dioxide. There has never been a disposition as in the case of many other plant phenomena, to explain the movement of gases upon any other than purely physical principles. We have therefore to do simply with the question of the aids and hindrances to the establishment of an equilibrium between the gases inside and outside the plant, irrespective of whether the cells are alive or dead.

[1] Reprinted from the *American Naturalist* for February.

It has already been stated that the relative amounts of oxygen and carbon dioxide inside the plant are usually very different, and that within a few hours the relation of the two may be completely reversed. To this may be added that the pressure of the gases inside the plant is sometimes more, sometimes less than that of the atmosphere outside the plant, almost never the same. Hales observed in his early work that a mercury gauge connected with the inside of the trunk of a tree showed an internal pressure when the hot rays of the sun warmed the trunk. This was largely due, undoubtedly, to an expansion of the gases in the trunk, by the heat. Such an excess of pressure in water plants is very common, although due to other causes. It may readily be shown by breaking stems under water, when bubbles of gas will be liberated, as undoubtedly many have noticed in gathering water lilies, or other water plants.

On the other hand, the pressure of the gas inside the plant may be less than on the outside. This has long been recognised, but was best demonstrated by Von Höhnel in 1879, to whom it occurred to cut off stems under mercury. In doing so the mercury rose to a considerable height in the vessels of the stem, and as mercury is without capillarity, this can only be ascribed to the greater pressure of the outside air, or in other words, to a partial vacuum in the plant.

An observation was made by Hales, which we may use to illustrate how such a negative pressure, as it has been called, can be brought about. He cut off a branch, fastened an empty tube to the cut end, and plunged the other end of the tube into a liquid. He found that as evaporation of moisture from the leaves took place, the liquid was drawn up into the empty tube. This phenomenon can now be explained more satisfactorily than could be done at that early day. By evaporation the liquid water inside the plant escapes in the form of vapour, and the space it occupied is filled by the gases, thus rarifying them. This rarifaction may go on in uninjured plants until the internal pressure is greatly reduced. But in the experiment, the pressure is equalised by the rise of the liquid in the tube. A later modification of Hales' experiment is to use a forked branch, place the cut end in water to give a continuous supply of moisture for transpiration, and attach the empty tube to one of the side forks of the stem, cut away for that purpose.

It is self-evident that such condensation and rarifaction of the gases in the plant could not take place if the cell walls were readily permeable to gases. Thus it comes about that one of the most important topics in connection with the movement of gases in the plant, is the permeability of tissue walls of various kinds, and especially those constituting the surface covering of plants.

I shall not attempt to conduct you through the tangle of supposition and fact, errors in experiments, correct and incorrect conclusions, and the general confusion which has come from the labours of physicists, chemists and botanists for the last twenty-five years, during which the subject has received particular attention. The results of the later work have been to cast grave doubts upon the correctness, or at least the interpretation of some of the experiments most relied upon heretofore. Nevertheless many points still lie open for verification, and untouched parts of the subject await investigation.

In the earlier days it was found that the leaves and young stems of plants have their epidermis more or less well supplied with minute openings, called stomata, or breathing pores, which communicate with small air cavities inside, which in turn branch out among the cells into a network of minute passages rarifying throughout the plant. This intricate network of intercellular passages affords an air communication throughout the whole plant, and connects directly with the outside atmosphere through the stomata. Subsequent to the discovery of stomata, it was ascertained, that in stems more than one year old, the stomata are replaced by another kind of opening, known as lenticels, which in some form are doubtless to be found in the bark of shrubs and trees of whatever age.

Gases stream into and out of the plant through the stomata and simpler lenticels, according to the law governing the movement of gases through minute openings in thin plates. The rate of movement is accordingly proportional to the square roots of the density of the mixing gases. Such a movement of gases is known as effusion.

The movement by which gases pass from one part of the

plant to another, through the intercellular spaces, is governed by other laws. It was at first thought that the rate of movement would correspond to that in capillary tubes, according to the well-known law of Poiseuille, that it is proportional to the fourth power of the diameter, divided by the length of the tube. But upon testing the matter two years ago, Wiesner found that owing to the extreme minuteness of the intercellular spaces, and their zigzagged and branched condition, this law does not hold, neither does the movement prove to be proportional to the density of the gases. The discovery of the law of the rate of movement of gases in intercellular spaces, that is, the transpiration of gases, is, therefore, yet to be discovered, together with other interesting facts pertaining to the subject. Poiseuille's law does, however, hold good for the movement of gases in the woody ducts, but here it is of limited application, for these do not connect with one another, with the intercellular spaces, or with the exterior of the plant.

The walls of most cells, ducts, and surface covering of plants, except as already mentioned, are imperforate, that is without any openings that can be demonstrated by the microscope. If gases pass through them, it must be in accordance with some law of diffusion, or osmosis. Many experiments in this line have been tried, and the results have been of the most diverse character. It is impossible to give a fair idea of the subject in the time at my disposal, and it must suffice to mention a few bare facts.

The most astonishing and important results were obtained by Wiesner, in experiments conducted at Vienna, two years since. It would be a most natural interpretation, it seems to me, to think that the gases are forced from one cell to another, through the cell walls by differences in pressure. Wiesner found, however, that it is impossible to force gases through cell walls of any kind whatever, by any pressure they will stand, acting for any length of time. For instance, a bit of grape skin held up a column of mercury, 70 centimetres high, for seventy-five days, and a piece of cherry skin withstood a pressure of 3 atmospheres for twenty-four hours. Similar experiments were tried with cuticularised, suberised, liquefied and simple cellulose tissues from many sources, and with uniformly the same results, whether the tissues were moist or dry, alive or dead.

But in the same set of experiments it was found that if gases cannot be forced through cell walls, they will readily pass through by simple osmotic diffusion. All cells permit the passage of gases by diffusion when moist, dependent upon the coefficient of absorption and the density of the gas. Cuticular and corky formations also permit the passage of gases when dry. Thus we see that gases may be forced through the stomata, or breathing pores, by varying pressure, but can only pass through the epidermis and bark of plants by diffusion. We therefore arrive at the conclusion that the gases inside and outside of the plant are brought to an equilibrium by direct interchange through the stomata and intercellular spaces, aided by the comparatively slow process of diffusion through the whole surface of the plant, both above and below ground.

J. C. Arthur.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Oxford.—The Curators of the Hope Collections will proceed to the election of a Hope Professor in Trinity Term 1893. Candidates for the Professorship, of which the emoluments are £480 per annum, are required to send in their applications, together with such evidence of their qualifications as they may wish to submit to the Curators, on or before May 1, 1893, to the Registrar of the University, Clarendon Buildings, Oxford. The duties of the Hope Professor are, to give public lectures and private instruction on zoology with special reference to the Articulata, to arrange and superintend the Hope collection of annulose animals, and to reside in the University for the term of eight months in every academical year between October 1 and July 15.

Physiological Department.—It is satisfactory to note that the number of students in this department is greater than in any previous corresponding term. The increase is due not only to the larger number of candidates for the M.B. degree, but also to a larger number of candidates for honours in Physiology in the Honour School of Natural Science. The course of study during the term has comprised lectures on the general subjects of the Honour School by the Waynflete Professor on the physiology of nutrition, by Dr. J. S. Haldane; and on the nervous System, by Dr. E. Starling. Mr. Leonard Hill has undertaken the course of lectures on elementary physiology. Practical instruction has been carried on under the superintendence of Dr. Haldane and Mr. M. S. Pembrey.

SCIENTIFIC SERIALS.

Bulletin of the New York Mathematical Society, Vol. ii. No. 4 (New York, 1893).—The contents of this number are an abstract of a paper (read before the Society, June 4, 1892) by Prof. W. Woolsey Johnson, entitled "On Peters's Formula for Probable Error" (pp. 57–61). A clear abstract of Engel and Sophus Lie's Theorie der Transformationsgruppen, by C. H. Chapman (pp. 61–71), and a similar account of U. Dini's work on the theory of functions of a real variable, by J. Harkness (pp. 71–76). Notes and new publications complete the number.

Bulletin de l'Académie Royale de Belgique, No. 12.—An unpublished corollary of Kepler's laws, by F. Folie. A deduction of Dewar's empirical formula for the ratios of the mean velocities of the planets from Kepler's third law.—On the common cause of surface tension and evaporation of liquids (preliminary note) by G. Van der Mensbrugghe. The author endeavoured to show in 1886 that the particles of a liquid are at distances apart which increase as we approach the surface, and that therefore the tension is greatest at the surface. Following up this view, he regards surface tension as the elastic force due to tangential displacement of surface particles, and evaporation as produced by molecular displacement beyond a certain limit in a direction normal to the surface. He predicts that a liquid of high surface tension will be able to evaporate across another liquid which has a lower density and surface tension, and does not mix with the former.—On a new optical illusion, by M. J. Delbœuf.—On the reduction of invariant functions in the system of geometric variables, by Jacques Deruyts.—Construction of a complex system of straight lines of the second order and the second class, by François Deruyts.—Contribution to the study of diastase, by Jules Vuylsteke.—Pupine, a new animal substance, by A. B. Griffiths.—Two experimental verifications relative to refraction in crystals, by J. Verschaffelt. Billet has calculated that if refraction takes place on a cleavage face of a crystal of Iceland spar, the angle of refraction for the extraordinary ray corresponding to normal incidence is 6°12′, and that the ray is normal with an incidence of 9° 49′. M. Verschaffelt has determined these angles experimentally, and found them to be 6° 9′ and 9° 45′ respectively, thus showing a close agreement with the theoretical values.—On the bacterian fermentation of sardines, by M. A. B. Griffiths.—On prejudices in astronomy, by M. F. Folie.—On the constitution of matter and modern physics, by P. de Heen.

Ann. dell' Ufficio Cent. Meteor e Geodinamico, ser. secund., part iii. vol. xi. 1889. Roma, 1892.—Fumo di Vulcano veduto dall' Osservatorio di Palermo durante l'eruzione del 1889, by A. Ricco.—From the obervatory terrace (72m. above sea level) the summits of some of the Lipari islands are visible, but that of Vulcano (140km. distant) is not so. Any smoke or vapour that exceeds 300m. in height can, however, be seen. The author was not successful in either photographing or measuring the dimensions of the smoke cloud, which were, however, estimated by comparison with the size of Alicuri, which had been carefully determined. At the commencement of the observations (January 6, 1889) the smoke column reached a height 10½km. and had the form of the pine tree. Several drawings are given, and the form assumed in some cases is very curious. The paper terminates with some thermodynamical calculations, which are very interesting, but unfortunately based on false premises. The author supposes that the eruption was caused by the access of the sea-water. He supposes this to be at sea level, and calculating the pressure at this point, concludes the vapour was produced from water heated to 196° C. only. He seems to be unacquainted with the solution of H_2O in the fluid volcanic glass, the vesiculation and escape of vapour from it, involving so many data with which the physicist has not yet supplied us, as to make any calculations of such a nature of a highly romantic rather than of practical use.

Mem. Soc. degli Spettroscopisti Ital. vol. xxi. 1892.—La Grandissima Macchia Solare del Febbrajo 1892, by A. Ricco.—This memoir is a description of an enormous sun-spot which developed from some small ones that had been noticed during three rotations before January 17. On February 5, they made their grand entry on the solar face on the east side, and by the 7th could be seen by the eye aided only by a smoked glass. The whole spot was composed of a very large one surrounded by smaller ones, and composed of great tongues of flame extending in towards the nucleus, sometimes arranged in a spiral manner. It attained its maximum on February 11, when the whole patch measured, in earth diameters, as follows: Total length, 20; total breadth, 8; the more compact extended 8 in each direction. After this the breaking up of the spot proceeded at a rapid rate, and by rotation the spot passed out of sight on the 18th. On the next rotation the diminution was much more marked. The author gives six observations of latitude, eight drawings, and several spectroscopic observations on the flames.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 23.—"On the Mimetic Forms of certain Butterflies of the Genus *Hypolimnas*." By Colonel C. Swinhoe, M.A. Communicated by Prof. E. Ray Lankester, F.R.S.

The object of this investigation is to study the changes undergone by the species of a small group of butterflies as they are traced from one locality to another, and to ascertain the bearing of these facts upon the theory of mimicry.

We find the representatives of the Indian *Hypolimnas bolina* in a long list of localities in Malaya, Polynesia, and Africa: the local representatives differ from each other and from the Indian form, but they agree in possessing in one or both sexes a more or less superficial resemblance to some conspicuous species belonging to a specially defended group and inhabiting the same locality; the same is true of the three forms of the female of *Hypolimnas misippus*.

The facts afford the most convincing evidence of the truth of the theory of mimicry enunciated by H. W. Bates.

The study of these numerous but closely-related forms belonging to the genus *Hypolimnas* also throws light upon such interesting questions as:—

(1) The special liability of the female to become mimetic.

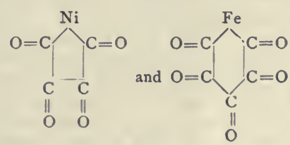
(2) The ancestral form from which the various mimetic varieties have been derived.

(3) The mimetic resemblance to different species in the same locality.

(4) The divergent conditions under which mimicry appears in closely-related species.

(5) The relation between selection and variation in the production of mimetic resemblance.

Physical Society, February 10.—Annual general meeting.—Mr. Walter Baily, Vice-President, in the chair.—The reports of the Council and Treasurer were read and approved, copies of the balance-sheet being distributed to members. From the former it appears that the society now numbers 371 ordinary members and 12 honorary members, and during the past year the society has lost six members by death, viz. the Rev. T. Pelham Dale, Dr. J. T. Hurst, B. Loewy, C. E. Walduck, G. M. Whipple, and P. W. Willans. Obituary notices accompany the report.—The treasurer's statement shows the financial condition of the society to be satisfactory. A cordial vote of thanks to the Committee of Council on Education for the use of the rooms and apparatus of the Royal College of Science was proposed by Mr. Shelford Bidwell, seconded by Mr. Blakesley, and carried unanimously. A similar vote was accorded to the auditors, Mr. H. M. Elder and Mr. A. P. Trotter, on the motion of Dr. Gladstone, seconded by Prof. S. P. Thompson. Prof. Ramsay proposed a vote of thanks to the officers of the society for their services during the past year; this was seconded by Prof. Fuller, and carried. Prof. Perry responded. The following gentlemen were declared duly elected to form the new council:—President: Prof. A. W. Rücker, F.R.S. Vice-Presidents: Walter Baily, Major-General E. R. Festing, F.R.S.; Prof. J. Perry, F.R.S.; Prof. S. P. Thompson, F.R.S. Secretaries: H. M. Elder, 50, City Road, E.C.; and T. H. Blakesley, 3, Eliot Hill, Lewisham, S E. Treasurer: Dr. E. Atkinson, Portesbery Hill, Camberley, Surrey. Demonstrator: C. Vernon Boys, F.R.S., Physical Laboratory, South Kensington. Other members of Council: Shelford Bidwell, F.R.S., W. E. Sumpner, Prof. G. Fuller, J. Swinburne, Prof. J. V. Jones, Rev. F. J. Smith, Prof. G. M. Minchin, L. Fletcher, F.R.S., Prof. O. Henrici, F.R.S., James Wimshurst.—In response to invitations for suggestions regarding the working of the society, Prof. S. P. Thompson said all must appreciate the efforts of the late Council, and particularly of the honorary secretaries, in making the society better known. But he could not help thinking that there were many persons amongst teachers of physics and scientific amateurs whose active sympathies it was desirable to engage, who were not yet associated with the society. Perhaps the time of meeting was not convenient for all, but he thought much might be done by freely circulating particulars of what was going on at the meetings. The daily papers merely announced the meetings, but said nothing as to the place of meeting or the papers to be read. In his opinion the society did not take the position in the scientific world to which it was entitled, and he wished to inspire members with a determination to bring its claims prominently forward.—Mr. Blakesley pointed out that almost all the scientific and technical papers gave full announcements of the meetings and of the papers to be read.—Mr. W F. Stanley said Friday afternoon was not convenient for scientific men engaged in trade.—The meeting was then resolved into an ordinary science meeting.—Dr. J. H. Gladstone, F.R.S., read a paper on some recent determinations of molecular refraction and dispersion. The paper relates to the new metallic carbonyls, the metals indium and gallium, sulphur, and to liquefied oxygen, nitrous oxide, and ethylene. The carbonyls were found to be extremely refractive and enormously dispersive. For iron pentacarbonyl, $Fe(CO)_5$, the molecular refraction for the line α of hydrogen was found to be about 68·5, and the molecular dispersion between γ and α of hydrogen 6·6. For nickel tetra-carbonyl, $Ni(CO)_4$, the corresponding numbers are 57·7 and 5·93. In discussing the results it was pointed out that if the molecular refraction of CO be taken as 8·4, the value expected in organic substances, then the atomic dispersions of nickel and iron come out greatly in excess of the known values as determined from solutions of their salts. The author considers the most probable explanation of the excessive refractions and dispersions of the carbonyls is to be sought in the peculiar arrangement of the CO, and on optical as well as chemical grounds accepts the ring formulæ indicated by Mr. Mond in his lecture at the Royal Institution, viz.:—



On this supposition the molecular refraction of CO comes out 11·9 from the nickel compound and 11·3 from the iron ore, whilst the molecular dispersion (γ—α) is about 1·3 in each case. For indium and gallium the atomic refractions calculated from latest data are 13·7 and 11·6 respectively. Sulphur has been examined in the states of solid, liquid, and gas, and also in simple chemical combination and in solution, all the resulting numbers for its atomic refraction being remarkably concordant. For the line C this is about 16. The dispersions in all the different states are also in close agreement. Numbers relating to carbon and chlorine are also given. The specific refractions of oxygen, nitrous oxygen, and ethylene in the liquid states had been recently determined by Profs. Liveing and Dewar. For liquid oxygen the refraction equivalent (3·182) differs little from that deduced from gaseous oxygen at ordinary temperatures (3·0316), and also corresponds fairly closely to the 3·0 obtained by Landolt from organic compounds. Liquid nitrous oxide gave 11·418 and 11·840 as the molecular refractions for the red ray of lithium and the line G respectively. In discussing these numbers it was pointed out that nitrogen in nitrous oxide was not in the same condition as nitrogen in ammonia. The latest determinations with liquid ethylene gave the molecular refraction for the line A as 17·41, the theoretical value being 17·40, thus showing very close agreement.—Mr. E. C. C. Baly made a communication on separation and striation of rarefied gases under the influence of the electric discharge.

Chemical Society, February 3.—Dr. W. H. Perkin, Vice-President, in the chair. The following papers were read:—The connection between the atomic weight of the contained metals and the magnitude of the angles of crystals of isomorphous series, by A. E. Tutton. The author has made a detailed goniometrical investigation of twenty-two salts belonging to the $R_2M(SO_4)_2,6H_2O$ series of double sulphates containing as the alkali metal R potassium, rubidium or cæsium, and as the dyad metal M magnesium, zinc, iron, manganese, nickel, cobalt, copper, or cadmium. On classifying the salts into three groups according to the alkali metals which they contain, it is found that the geometrical and other properties of the salts containing rubidium as the monad metal, lie between those of the corresponding potassium and cæsium salts. Thus the cæsium salts show the greatest power of crystallising, those of potassium the least, whilst the salt containing rubidium occupy an intermediate position in this respect. Similar behaviour is observed with regard to the crystalline habits of the various salts; each of the three groups is characterised by the possession of a distinctive habit. The crystalline habit of the salts containing potassium is widely different from that of the salts containing cæsium; the specific characteristic habit of the rubidium salts is of an intermediate nature. There is a difference of some two degrees or so between the axial angles (β) of the potassium and cæsium salt crystals containing the same dyad metal; the magnitude of the angle β in the corresponding rubidium salt is approximately the mean of these two. The differences between the axial angles are hence approximately proportional to the differences between the atomic weights of the contained alkali metals if the dyad metal remain the same. The magnitudes of all the angles between the faces of the crystals of the salts of this series containing rubidium as the alkali metal lie between, though not ordinarily midway between, the magnitudes of the corresponding angles upon the crystals of the potassium and cæsium salts containing the same dyad metal. The alkali metals exert a preponderating influence upon the geometrical form of the crystals, the magnitudes of the angles being altered on displacing one alkali metal R by the next higher or lower to an extent attaining a maximum, in certain angles, of more than a degree, whilst the displacement of the dyad metal M by any other of the same group is unattended by any material change in the angular magnitudes.—The preparation of phosphoric oxide free from the lower oxide, by W. A. Shenstone and C. R. Beck. Phosphoric oxide may be freed from the lower oxides by distilling it over platinum sponge in presence of excess of oxygen.—Contributions to our knowledge of the aconite alkaloids: Part iv., on isaconitine (napelline), by W. R. Dunstan and E. F. Harrison. The authors have examined the alkaloid isaconitine $C_{33}H_{45}NO_{12}$, which occurs together with its isomeride aconitine in the roots of *Aconitum napellus*. It is present to as great an extent as aconitine, and is obtained in the pure state as a colourless, friable, varnish-like mass. Its alcoholic solution is feebly dextrorotatory. The salts somewhat resemble the corresponding aconitine salts in physical properties. On attempting to prepare an aurichloride, aurochlorisaconitine, $C_{33}H_{44}(AuCl_2)NO_{12}$, results. Isaconitine is gradually hydrolysed by mineral acids or water yielding the same products as does aconitine, viz. aconine and benzoic acid

$$C_{33}H_{45}NO_{12} + H_2O = C_{26}H_{41}NO_{11} + C_7H_6O_2.$$

Whilst aconitine is a most violent poison, even in excessively minute doses, relatively large quantities of isaconitine must be administered to small animals in order to produce a toxic effect, which effect is the result of a physiological action in the main distinct from that of aconitine. It seems doubtful whether isaconitine would prove toxic to man, except when given in very large doses.—Contributions to our knowledge of the aconite alkaloids: Part v., the composition of some commercial specimens of aconitine, by W. R. Dunstan and F. H. Carr. The great differences in toxic power exhibited by different samples of aconitine have led the authors to examine sixteen specimens of "aconitine from *A. napellus*." Most of the samples were amorphous; these contained little or no aconitine, but were chiefly composed of aconine, isaconitine, and homoisaconitine, all of which appear to be very slightly, if at all, toxic. Of the crystalline specimens examined, only two were pure, most of them being contaminated with more or less amorphous alkaloid. Hence it is not surprising that great differences have been observed in the mode of action and toxic power of commercial "aconitine."—Synthesis of oxazoles from benzoin and nitriles, by F. R. Japp and T. S. Murray. The authors find that nitriles and benzoin interact with elimination of water when a mixture of the two compounds is dissolved in concentrated sulphuric acid, an oxazole being formed in which the hydrocarbon radicle attached to the cyanogen of the nitrile occupies the *meso*-position. Thus acetonitrile yields in this manner $\alpha\beta$-diphenyl-μ-methyloxazole

$$\begin{array}{l}\text{Ph.CH.OH}\\ \quad\;|\\ \text{Ph.CO}\end{array} + \text{NC.Me} = \begin{array}{l}\text{Ph.C.O}\\ \quad\;\|\\ \text{Ph.C.N}\end{array}\!\!\!\!\Big\rangle\text{C.Me} + H_2O.$$

A number of instances of this reaction are cited. The above oxazole, when treated with ammonia, is converted into the corresponding imidazole identical with Japp and Wynne's methyldiphenylglyoxaline.—The action of nitrosyl chloride and of nitric peroxide on some members of the olefine series, by W. A. Tilden and J. J. Sudborough. Ethylene dichloride alone results from the interaction of ethylene and nitrosyl chloride. Propylene and butylene yield with nitrosyl chloride a mixture of dichloride and nitrosochloride, whilst trimethylene (amylene) is almost entirely converted into nitrosochloride.—Piperazine, by W. Majert and A. Schmidt. The authors correct certain erroneous statements regarding the physical and chemical characters of piperazine. They have prepared the following series of hydrates of piperazine, the hexhydrate, which crystallises from dilute aqueous solutions, being the most readily formed:—

$C_4H_{10}N_2, H_2O$	m. p.	75°
,, , $2H_2O$	,, ,,	56°
,, , $3H_2O$	,, ,,	39-40°
,, , $4H_2O$	,, ,,	42 43°
,, , $5H_2O$	,, ,,	45°
,, , $6H_2O$	,, ,,	48°

Linnean Society, February 16.—Prof. Stewart, President, in the chair.—Mr. Clement Reid exhibited and gave an account of some seeds of *Paradoxocarpus carinatus*, an extinct Pliocene and Pleistocene plant from the Cromer fossil bed. Mr. Reid also exhibited and described some examples of *Potamogeton headonensis*, a new type of pond weed from the Oligocene strata of Hordle Cliff in Hampshire. His remarks, which were listened to with great interest, were elucidated with the aid of diagrams, and were criticised by Mr. W. Carruthers and others.—Mr. J. E. Harting exhibited some dried plants of a so-called Greek tea (*Sideritis theezans*, Boissier), which during a recent visit to Thessaly he had found to be extensively used there, as an infusion in lieu of tea. He also exhibited some photographs of Thessalian scenery, showing the geological and botanical character of the country bordering the great plain of Larissa.—Dr. Otto Stapf pointed out on the map the scene of Bornmueller's recent botanical explorations in Persia, and gave some account of the flora of that region as far as has at present been ascertained.—On behalf of Mr. C. B. Plowright, a paper, communicated by the President, was read on the life history of the Æcidium on *Paris quadrifolia*.—On behalf of Mr. J. C. Willis, who was unfortunately prevented by illness from attending, a paper was read entitled "Contributions to the natural history of the flower." This paper, the first of a series, dealt with the fertilisation by insects of plants belonging to the genera *Claytonia*, *Phacelia*, and *Monarda*.—Some observations on British worms, by the Rev. H. Friend, were read on his behalf by the Secretary.

Royal Meteorological Society, February 15.—Dr. C. Theodore Williams, President, in the chair.—The following papers were read:—Report on the phenological observations for 1892, by Mr. E. Mawley. The Royal Meteorological Society has for a number of years past collected observations on natural periodical phenomena, such as the date of the flowering of plants, the arrival, song, and nesting of birds, the first appearance of insects, &c. These observations were supervised and discussed by the Rev. T. A. Preston until 1888, since which time they have been under the direction of Mr. E. Mawley. The year 1892 was on the whole very cold and backward. The frequent frosts and dry weather during the first five months greatly retarded vegetation, and consequently all the early wild flowers were very late in coming into blossom. Bush fruits and strawberries were, as a rule, good and fairly plentiful. Plums and pears were almost everywhere a failure, and apples were considerably under the average. The wheat crop was a very light one, owing in part to the attacks of blight brought

on in many places by the frost in June. Oats, beans, and peas were much under the average, while barley was the chief crop of the year. Potatoes, turnips, and mangolds were above the average. During August butterflies were very numerous, the clouded yellow butterfly being exceptionally abundant.—Relation between the duration of sunshine, the amount of cloud, and the height of the barometer, by Mr. W. Ellis. This is a discussion of the observations made at the Royal Observatory, Greenwich, during the fifteen years 1877-91, from which it appears that in the months from February to October there is, on the whole, a distinct probability of increased sunshine and correspondingly less cloud with increase of barometer reading. The winter in all conditions of the barometer is uniformly dull. Mr. Ellis says that it is evident that high barometer in summer presages increased sunshine, that the effect is less pronounced in early spring and late autumn, and that it becomes slightly reversed in winter.—Winter temperatures on mountain summits, by Mr. W. Piffe Brown. In this paper the author gives the lowest winter temperature on the summit of Y Glyder fach, four miles E.N.E. from Snowdon, and 3262 feet above sea level, as recorded by a minimum thermometer during the last twenty-five years. The lowest temperature registered was 9° during the winter 1891-2.

Zoological Society, February 14.—Osbert Salvin, F.R.S., Vice-President, in the chair.—The secretary read a report on the additions that had been made to the Society's menagerie during the month of January 1893.—Prof. G. B. Howes exhibited and made remarks on an abnormal sternum of a Marmoset (*Hapale iacchus*) in which the mesosternal elements of the opposite sides were distinct, and alternately disposed, and discussed its probable bearings upon the sternum of the Anthropomorpha, particularly as represented by the orang.—Prof. T. Jeffrey Parker, F.R S., read a paper on the cranial ostelogy, classification, and phylogeny of the *Dinornithidæ*. The author gave a detailed description of the skull in various genera and species of Moa, founded upon the examination of more than 120 specimens. A detailed comparison with the skulls of the other Ratitæ followed, as well as an extensive series of measurements. —The bearing of the facts ascertained upon the classification of the family was discussed. The author recognised five genera of *Dinornithidæ*, arranged in three subfamilies as follows: Subfamily DINORNITHINÆ, genus *Dinornis*; subfamily ANOMALOPTERYGINÆ, genera *Pachyornis*, *Mesopteryx*, and *Anomalopteryx*; subfamily EMEINÆ, genus *Emeus*. The phylogeny of the group was then discussed. *Mesopteryx* was considered to be the most generalised form, while *Dinornis* and *Emeus* were both highly specialised, but in different directions. Of the other Ratitæ, *Apteryx* came nearest to the Moas in the structure of its skull, and strong affinities were shown to the New Zealand genera by *Dromæus* and *Casuarius*. *Struthio* and *Rhea*, on the other hand, showed no special affinities, so far as the skull is concerned, either to the Australasian forms or to one another.—Mr. R. Lydekker read a paper on the presence of a distinct coracoidal element in adult sloths, and made remarks on its homology. It was shown that in two skeletons of sloths in the British Museum the shoulder-girdle exhibited a distinct coracoidal element. This element, like the coracoid process of the human scapula, was correlated with the precoracoid of the lower vertebrates; and the question was then discussed as to the name by which it should properly be called.—A communication was read from Dr. G. Radde, containing an account of the present range of the European bison in the Caucasus.

OXFORD.

Junior Scientific Club, Feb. 17.—In the Morphological Laboratory.—The President in the chair.—Mr. A. L. Still gave an exhibit of a variety of a common pheasant, which was shot near Croydon. This proved to be an extremely light-coloured young cock.—Mr. H. Balfour gave an exhibit of some modern Klepsydræ, such as are now used in guard rooms in many parts of Northern India and Burmah. He also showed some water clocks from Burmah, one of which was of interest as having come from the Imperial Palace of Mandalay, where it was the public standard of time.—Dr. Leonard Hill read an account of his researches on the gas evolved from muscles.—Mr. H. V. Reade read a paper on consciousness, and the unconscious, citing several cases of dual personality, and showing that memory could be explained by purely physiological reasoning.

EDINBURGH.

Royal Society, February 6.—Sir Arthur Mitchell, K.C.B., Vice-president, in the chair.—Mr. John Aitken read a paper on the particles in fogs and clouds. In a paper read some time since on the water particles in clouds, Mr. Aitken came to the conclusion that there was a relation between the density of the clouds and the number of water particles present. In May last year he made further observations, and got results opposite to the former. Instead of the density being nearly proportional to the number of water particles present, it was much short of proportionality, and the particles were small in size. Mr. Aitken points out that the size of the particles of water changes with the age of the clouds, and concludes that his first observations were made upon old clouds, while the latter series were made upon newly-formed clouds. He also considered the question of the persistence of fog-particles. There are two kinds of fog. In one the particles tend to persist, in the other they do not. That is, in one case, change of size of the particles takes place rapidly; in the other it does not. In town fogs it is not so much the number of dust particles that is of importance as their composition. If town dust were composed of particles having an affinity for water the fogs would have shorter duration.—Sir Douglas Maclagan described and explained an apparatus designed by Mr. J. Buchanan Young, Public Health Laboratory, Edinburgh University, for counting bacterial colonies in roll cultures.—A note, by Prof. Anglin, on properties of the parabola, was read.—Mr. A. J. Herbertson read a preliminary note on the hygrometry of the atmosphere at Ben Nevis. He finds that the observations already made agree well with the formula $y = ax + bw + c$; where y is the difference between the readings of the dry and wet bulbs, x is the temperature of the dry bulb, w is the weight of moisture per litre, and a b c are constants.

DUBLIN.

Royal Dublin Society, January 18.—Prof. W. J. Sollas, F.R.S., in the chair.—Dr. J. Joly, F.R.S., read a paper on the cause of the bright colours of Alpine flowers. The conditions of insect life upon the higher Alps are referred to in this paper as bearing upon the question. Observations made by the author show that many thousands of bees and butterflies frequently perish in the cold of night-time on Swiss glaciers and firns. The author advocates the view that the scarcity of fertilising agents promotes a struggle for existence in the form of a rivalry to attract the attention of the fewer fertilisers by vivid colouring.—Prof. G. A. J. Cole read a paper on *Hemitrypa hibernica*, M'Coy.—A paper was read on a suggestion as to a possible source of the energy required for the life of bacilli, and as to the cause of their small size, by Dr. G. Johnstone Stoney, F.R.S., Vice-President.—Prof. W. J. Sollas, F.R.S., read a paper on the law of Gladstone as an optical probe.

February 22.—Prof. W. J. Sollas, F.R.S., in the chair.—Mr. Thomas Preston read a lecture note on the principle of work, showing that since the virtual work of a force is equal to the movement of an equal force at right angles to it, the principle of virtual work follows immediately as a corollary to the theorem of movements.—Prof. D. J. Cunningham, F.R.S., communicated a paper by Prof. A. M. Paterson on the human sacrum.—Prof. A. C. Haddon communicated a paper by Miss Florence Buchanan on *Eunice phylocorallia*, n. sp., commensal with *Lophohelia prolifera*.

PARIS.

Academy of Sciences, February 20.—M. de Lacaze-Duthiers in the chair.—Description of an instrument to show the small variations in the intensity of gravitation, by M. Bouquet de la Grye. The instrument, which has been set up in a cellar of the Dépôt de la Marine, consists of an iron tank containing hydrogen confined over mercury, with three tubes leading out through the bottom. Two of these tubes are bent upwards to about 40 cm. above the ground. One of them is used for filling the tank with mercury, the other for letting in the hydrogen, which is accomplished by letting mercury run out through the third pipe at the bottom. The second pipe ends in a horizontal tube made of glass, through the walls of which the fluctuations of the column of mercury sustained by the elastic force of the hydrogen can be observed. By means of an alcohol thermometer immersed in the mercury on the top of the tank, changes of temperature of one-thousandth of a degree are indicated by a move-

ment of 1 mm. The column oscillates with each change of temperature and each variation of gravitation, but is not affected by changes of pressure, since the tube is kept closed at the top. Under these circumstances, the instrument in question is capable of indicating the change of gravitational force due to the change in the position of the moon by a displacement of 0·46 mm. The apparatus is difficult to set up, and will require some improvement before it can give trustworthy results.—Observation on the conditions which appear to have obtained during the formation of meteorites, by M. Daubrée. The heterogeneous structure of meteorites, the innumerable iron granules disseminated through the stony matrix, so different from the well-defined and voluminous crystals obtained by the fusion of the constituent minerals in the laboratory, and M. Stanislas Meunier's success in imitating meteorites by means of gaseous reactions, lead to the conclusion that they have not been produced by fusion, but by a sudden precipitation of different gases into the solid state.—On the preparation of uranium at a high temperature. Rapid preparation of chromium and manganese at a high temperature, by M. Henri Moissan (see Notes).—On stereochemistry, by M. C. Friedel.—On the benzoates and metanitro-benzoates of diazoamidobenzene and para-diazoamidotoluene, by MM. A. Haller and A. Guyot.—High atmospheric pressures observed at Irkutsk from January 12 to 16, 1893, by M. Alexis de Tillo. During four days the barometer remained above 800 mm., and on January 14 the highest value known up to the present, 807·5 mm., was reached, the temperature being $-46°·3$ C.—M. Callandreau was elected Member in the place of the late Admiral Mouchez; and M. Kékulé Correspondent in the place of the late M. Stas.—Summary of solar observations made at the royal observatory of the Roman College during the last quarter of 1892, by M. P. Tacchini.—On the terms of the second order resulting from the combination of aberration and refraction, by M. Folie.—On the essential singularities of differential equations of a higher order, by M. Paul Painlevé.—Remarks on the preceding communication, by M. E. Picard.—On uniform integrals of linear equations, by M. Helge von Koch.—Generalisation of Lagrange's series, by M. E. Amigues.—On the part played by the steam jacket in multiple expansion engines, by M. A. Witz.—A direct-reading stereo-collimator, by M. de Place.—Hysteresis and dielectric viscosity of mica for rapid oscillations, by M. P. Janet. A comparison of differences of potential and resulting charges during rapid oscillations, determined by means of the apparatus described last year, reveals a lagging of the charge behind the potential, both increasing and decreasing, and a curve plotted with the values obtained for a mica condenser suggests some analogy with Ewing's curves of magnetic hysteresis.—Optical field, absolute, and relative field of view of the human eye, by M. C. J. A. Leroy.—On the achromatism of semicircular interference fringes, by M. G. Meslin.—A new system of atomic weights, partly founded upon the direct determination of molecular weights, by M. A. Leduc.—Decomposition of the alkaline aluminates by carbonic acid, by M. A. Ditte.—On mixtures of ether and water, by M. L. Marchis.—On the heat of formation of arragonite, by M. H. Le Chatelier.—On the crystalline forms of chromium and iridium, by M. W. Prinz.—Ammoniacal fermentation of earth, by MM. A. Muntz and H. Condon.—On the composition of the salts employed as condiment by the people about the Oubangui, by MM. J. Dybowski and Demoussy.—Oxyhæmatine, reduced hæmatine, and hæmochromogen, by MM. H. Bertin-Sans and J. Moitessier.—On the histological alterations of the cerebral cortex in certain mental diseases, by M. R. Colella.—On the structure and growth of the calcareous shell of the barnacle (*B. tintinnabulum*), by M. Gruvel.—On the causes of the green colour of oysters, by M. S. Jourdain.—Geological remarks on the diamond-bearing meteoric irons, by M. Stanislas Meunier.

AMSTERDAM.

Royal Academy of Sciences, January 28.—Prof. van de Sande Bakhuysen in the chair.—Mr. Kapteyn dealt with the distribution of stars in space. It has been long known that the mean proper motion in the galaxy is smaller than elsewhere. A thorough investigation of the proper motion of *all* the stars of the Draper catalogue observed by Bradley in both co-ordinates (2357 stars) shows, that this fact is due to an excess of insensible or very small proper motion in the milky way. Those exceeding 0″·055 show no aggregation towards that zone. As far as the evidence goes, it further proves, by means of the angle subtended by the solar motion in space, that stars with equal proper motion *in* and *out* of the galaxy have nearly equal distances. These two facts taken together prove that Struve's theory of the arrangement of the stars in space must be abandoned. In order to find what arrangement must be substituted Mr. Kapteyn has considered the stars of the first and second spectral type separately, and arrives at the conclusion that the latter are very strongly condensed about a centre not far from our system, approximately in the direction of 0h. R.A. and $+42°$ of decl., whilst the stars of the first type are more nearly evenly distributed in the proximity of our sun. Notwithstanding this difference in arrangement Mr. Kapteyn thinks that probability points to the conclusion that the two types belong to one and the same system:—(1) Because the centre of condensation of the second type stars coincides very nearly with the apparent centre of the milky way (which seems to consist mainly of first type stars). (2) Because the stars with *insensible* proper motion of *both* types are strongly condensed towards the plane of the milky way. (3) Because groups of stars, which undoubtedly form stellar systems (*e.g.* Hyades) contain stars of both types.—Mr. van Bemmelen, in pursuing his inquiry on colloidal hydrates, spoke at the meetings of November 26, 1892, and of January 28, 1893, on the constitution and composition of the hydrogels of S_1O_2 and of CuO, as these result from his determinations of their tension of vapour (at 15°), changing in a continuous way with their tenure of water.—Mr. Kamerlingh Onnes showed the isodynamics of a new physical laboratory at Groningen, mapped under Prof. Haga's direction with the localvariometer by Mr. Wind, proving the excellent constancy of the magnetic field. A new theory of the localvariometer points to another ratio of distances of the deflecting magnet-pairs than that given by Kohlrausch as preferable.—Mr. Schoute treated of "the uniform representation of a cubic surface on a plane." Indication of the number of points common to two curves on F^3, the plane representations of which are given. Application as to the position of the twenty-seven lines with respect to one another.

CONTENTS. PAGE

THURSDAY, MARCH 9, 1893.

THEORY OF THE SUN.

Théorie du Soleil. By A. Brester, Jz., Docteur ès Sciences. (Amsterdam: Johannes Müller, 1892.)

DR. BRESTER'S preliminary account of his new theory of the sun has already been noticed in our columns (NATURE, vol. xxxix. p. 492). The present volume is a communication to the Amsterdam Academy of Sciences, and gives a complete statement of the principles and their application to the various solar phenomena. The author is careful to point out that he has not contributed a single fact of observation himself, but is content to rely on the work of others. Nevertheless, he is evidently a most careful student, and if his theory cannot be accepted, some of its points are well worth the attention of solar physicists.

Starting with the sun as a mass of incandescent vapours, it does not seem unreasonable to regard, with Dr. Brester, the conditions of such a mass of vapour from a purely chemical point of view. At certain temperatures combinations of some substances will become possible, heat will be developed, and various phenomena may be produced. Dr. Lohse[1] has already suggested that this kind of action might be the cause of the outburst of a new star.

Dr. Brester appears to unreservedly accept Mr. Lockyer's view, that many of the substances with which we are familiar in our laboratories are dissociated into their finer constituents at solar temperatures.

In accordance with the generally accepted notion, he also assumes the sun to be gaseous, and regards the photosphere as a shell of partially condensed matter. He rejects, however, the idea that the sun is in an almost constant state of agitation. Indeed, the unique point of his theory is that the sun is always in a state of perfect tranquillity, and that the so-called "eruptions" do not really indicate the actual displacement of matter, but simply the translation of the luminous condition. He boldly declares (p. 4) that "the solar eruptions do not exist," and looks to the known facts of chemistry to explain the multitudinous phenomena with which students of solar physics have to deal.

What Dr. Brester calls "New Astrochemical Principles" are stated as follows:—

Principle I.—All incandescent celestial bodies are tranquil in themselves, and their quiet interiors are such that the molecules of different densities, arranged by gravitation in concentric spheres, never lose their stratification.

Principle II.—The continued cooling of stars generally produces in their exterior layers an intermittent transformation of chemical energy in the form of heat, and thus produces periodical eruptions of heat.

Let us see how, with these premises, Dr. Brester treats some of the problems of solar physics.

The Formation of Spots.—According to the new theory, spots are openings in the photosphere produced by the heat developed in the chemical combination of dissociated molecules, part of the photosphere being evaporated when such an "eruption of heat" occurs. On this supposition the spot has the same temperature as the photosphere itself, the condition of things being somewhat similar to that of small pools of water in a mass of ice. Dr. Brester shows how this view gives an explanation of the proper motions and other phenomena of spots, but we must needs refer those interested to the book itself for full details.

The Stratification of the Sun's Atmosphere.—All solar physicists agree that in the solar atmosphere there is a stratification of some sort, but there are different views as to the exact nature of it. The old idea was that each vapour extended from the photosphere upwards, reaching to a height depending upon its density. This view had its birth in the observations showing that all the bright lines of the chromosphere appear to reach the photosphere, but Mr. Lockyer showed,[1] that as we have not to deal with a cross section in the observations, the same result would be obtained if the vapours were arranged in true shells. Mr. Lockyer follows up this important fact with the suggestion that the various layers are really concentric shells arranged according to their heat-resisting power, any particular substance finding its level where the temperature is just below that of dissociation for the vapour in question. Dr. Brester, however, goes back to the old view that the layers are arranged in the order of their specific gravities, but modifies it by supposing, with Mr. Lockyer, the vapours to lie in shells. Further, accepting the dissociation hypothesis, he regards some of these layers as finer constituents of what the chemists call elements.

Dr. Brester imagines that Mr. Lockyer's view demands that the most dissociated, and therefore the lightest molecules, should be found in the layers nearest to the photosphere, while the least dissociated, and therefore the heavier molecules, should appear in the outer layers. This, however, is not the case, according to our author; the lighter vapours, such as the hypothetical *helium* and hydrogen being furthest removed from the photosphere; while the heavier, such as iron, appear only in the lower levels. The whole subject has been very fully discussed by Mr. Lockyer in his "Chemistry of the Sun," and space does not here permit all the arguments to be restated. It may be mentioned, however, that, as Mr. Lockyer points out (p. 172), there is no evidence that the various metals are arranged according to densities; the case of magnesium and sodium is instanced, the heavier metal always showing the longer lines.

In a foot-note on p. 17 Dr. Brester states that the various elements need not always appear exactly in the order of their specific weights, "Car la hauteur où seront encore visibles les molecules d'une matière quelconque ne dépendra pas uniquement de leur poids mais de leur nombre aussi." It is by this bare statement that he attempts to explain the great height to which the H and K lines of calcium have been shown by recent photographs to extend, and presumably also such cases as that of magnesium and sodium, which has already been referred to. It is unnecessary to say more on this point, as Dr. Brester practically renounces this point of his theory

[1] *Berlin Akad. Monatsb.*, 1877, p. 826.

[1] "Chemistry of the Sun," p. 305.

The problem of the stratification of the sun's atmosphere does not, therefore, appear to have been advanced by his discussion of the various observations.

Dr. Brester's view of the solar surroundings leads him to suppose that the concentric layers which he postulates are ellipsoidal, so that the photosphere cuts different shells in different latitudes. The fact that there is an equatorial extension of some sort is abundantly demonstrated by eclipse photographs. In the application of this view to the explanation of some of the phenomena presented by the sun Dr. Brester displays considerable ingenuity, and we may refer to some of them, as they suggest points which may have to be taken into consideration in other theories.

The Solar Rotation.—It is a matter of common knowledge that the equatorial regions of the sun, as indicated by the spots, rotate more rapidly than the regions in higher latitudes. On Mr. Lockyer's hypothesis, which supposes sun-spots to be produced by the fall of condensed materials from the cooler regions of the atmosphere, this is explained by the fact that such atmosphere is highest at the equator, and the spot-forming matter thus having a greater forward velocity previous to its descent, will have a greater angular velocity on reaching the photosphere. Dr. Brester's view is a modification of this. Taking for granted that the solar layers are ellipsoidal, and that the photosphere is an independent partially condensed shell, he points out (p. 44) that when the matter of any particular layer condenses to form a part of the photosphere, the increase of density will cause it to descend towards lower layers, and as it will retain its initial velocity, the angular velocity in its new position will be increased. In this way he explains the law of solar rotation, but on account of the absence of knowledge of the densities of the vapours near the photosphere, the question cannot be treated mathematically. On Dr. Brester's view this law applies only to the photosphere itself, the ellipsoidal layers all having the same angular velocity.

This he further applies to the reconciliation of the spectroscopic determinations of the velocity which have been made by Dunér and Crew. Dunér's observations practically confirm the law derived from the observations of spots, while those of Prof. Crew show no change of velocity with change of latitude. Dr. Brester points out that most of the lines observed by Crew have been seen bright in the chromosphere, while those observed by Dunér have not been so recorded. Hence he concludes that the lines observed by Dunér are produced by the absorption of vapours actually lying in the interstices of the photosphere—and therefore indicating the same velocity—while those observed by Crew show only the uniform angular velocities of the ellipsoidal shells.

Changes in the Spectra of Sun-spots.—Dr. Brester's theory also gives an explanation of differences in the spectra of sun-spots at different parts of the spot-period. Observations have shown that at maximum the lines which are most widened in spot-spectra are chiefly lines of unknown substances, while at minimum they are chiefly lines of iron and other known substances. When it is remembered that there is a progression in latitude with the advance of the spot-period, Dr. Brester's view can readily be understood; the photosphere in each latitude will have a different composition, and hence change of latitude will be accompanied by change of spectrum. It is only fair to say that the exact nature of this change has not yet been fully investigated, and hence the explanation offered cannot strictly be put to the test. Broadly speaking, however, it is evident from what has already been said, that if Dr. Brester's view be correct, there must be a layer of unknown vapours cutting the photosphere about latitude 15° (the latitude of spots near maximum), and layers of the vapour of iron, or some of its constituents, cutting the photosphere about latitudes 5° and 30° (the latitudes of spots at minimum). Before the view can be properly tested, it is clear that we must have further knowledge as to whether the iron lines widened in spots of high latitude at the beginning of a sun-spot period are identical with those widened in spots near the equator towards the end of the period, and, so far as we know, information on this point is wanting.

The Periodicity of Solar Phenomena.—Dr. Brester first of all dismisses the suggestion of planetary disturbances as the phenomena usually seen are too irregular to be consistent with orbital motion; and other views are also found wanting. He then shows how the second of the astrochemical principles already referred to appears to him to give the necessary explanation. As in our notice of his first essay, we may say that the main idea is that during eleven years the integrated effects of the various chemical combinations which have taken place are such as to very nearly restore the conditions which had existed at the commencement of the period. Slight differences would be produced each time, so that after a long interval wide differences might be expected.

Many other problems are discussed, and Dr. Brester has satisfied himself that his theory is competent to explain them all. Want of space, however, will not permit further reference.

The volume will be a valuable one, if only for the fact that it brings together a great mass of work which has been done in connection with the sun—over 300 authors being quoted—and although we are not prepared to accept his theory in all its points, it is fair to say that some of his arguments are extremely suggestive, and may help in time to unravel some of the mysteries of our central luminary.

In subsequent communications Dr. Brester will extend his theory to the phenomena presented by variable stars, comets, and other celestial bodies. A. F.

ELEMENTARY BIOLOGY.

A Course of Practical Elementary Biology. By John Bidgood, B.Sc., F.L.S. (London: Longmans, Green, and Co., 1893.)

THIS book deals with certain of the types of animals and plants which are included in other elementary works on the same subject. The forms selected are yeast, protococcus, bacteria, mucor, penicillium, chara, fern, flowering plant, amœba, vorticella, paramœcium, hydra, mussel, crayfish, and frog. The author states that "the subjects dealt with cover most elementary biological courses, but apparently do not exactly fit any." The work has, therefore, at any rate, the merit of not having been written merely from the point of view of any particular examination syllabus. A certain amount of originality

is also seen in the attempt to combine a more general treatment of the subject with practical directions.

General instructions with regard to the microscope, microtome, and reagents, are given in the introduction; these, however, do not indicate a very wide personal acquaintance with the ordinary laboratory requirements, and the methods of preparation, &c., are mainly copied from Lloyd Morgan's "Animal Biology" and Howes's "Atlas of Practical Elementary Biology." The student is referred to a number of well-known text-books for further information, but it is curious that no mention is made of certain excellent elementary works treating more especially of the types described.

The part dealing with plants, which occupies rather more than half the book, is on the whole more satisfactory and contains fewer mistakes than that relating to animals. Most of the woodcuts in the former are taken from well-known sources, and a number of original figures are given of *Aspidium* and of *Lamium album*, which latter is selected as a type of the Phanerogams; the author has evidently worked out the structure of these forms with some care. In the zoological part many of Lloyd Morgan's diagrams have been utilised, and figures are also taken from various other text-books, such as Milnes Marshall's "Frog," Wiedersheim's "Comparative Anatomy," and Quain's "Anatomy." Most of those from the last-named work, with the corresponding descriptions, naturally do not refer to the frog at all, but this fact is not stated. Some of the drawings of invertebrates made by the author are very fair, though they do not indicate much originality; one or two others, such as that of an undischarged nematocyst of hydra, on p. 221, are bad. The sources from which borrowed figures are taken is not mentioned in all cases, although the contrary is stated in the preface.

The author shows very little power of selecting his facts, or of drawing conclusions from them in such a way as to clearly illustrate the general principles of the subject. Many of the details, moreover, are incorrect, and errors of the most serious character occur. It will be sufficient to refer to a few of these in order to indicate the author's looseness of expression and want of acquaintance of parts of the subject with which he deals.

The remarks on the structure and functions of the nucleus, and on the pulsating vacuole in protococcus (pp. 46 and 47) are, to say the least, misleading. This organism may, it is said, "be looked upon as a closed bag with a double wall—the outer of cellulose, and the inner of protoplasm" (p. 50), and the movements of its cilia "probably" drive it through the water (p. 48). The investment of the "spermocarp" of chara is called a "pericarp," and the pro-embryo a "prothallium" (pp. 88 and 89). The description of karyokinesis (p. 108) does not show much knowledge of recent observations. On p. 90, line 10 from top, the word "sexual" has by an oversight been printed as "several." The oosphere is confused with the fertilized ovum on p. 133, although the term oosperm is correctly used on previous and subsequent pages. The description of the part played by the nucleus in the processes of reproduction and conjugation in vorticella on pp. 211 and 212 is somewhat incomprehensible. One gathers on pp. 220 and 221 that it is comparatively easy to distinguish the nerve cells in hydra in preparations simply traced up in water and stained with methyl-blue, and in optical sections of the entire animal prepared with osmic acid. We may mention that it has recently been shown by Albert Lang that the bud in hydra is *not* "a product of both ectoderm and endoderm" as stated on p. 223. The Metazoa are said to be *all* "characterized by . . . the possession of a digestive cavity (*enteron*)" (p. 224). On p. 234 we read that the "kidneys (nephridia)" of the mussel are "sacculated organs whose walls carry a mass of tubules," and one gathers that the small irregular opening leading from the kidneys into the "ureter" is quite easy to recognise. Fig. 194A, representing the brain of the frog, is taken from the old figure by Ecker, in which the "olfactory lobes" are separated by a cleft, and the primary fore-brain is said to be the same thing as the thalamencephalon (p. 333). We do not see the object of introducing a description of the complicated human auditory apparatus in the chapter on the frog. The account of the processes of maturation, fertilization, and segmentation of the ovum of the frog is extremely incomplete and inaccurate, and one might even infer from one sentence on p. 331 that the nucleus was quiescent during the division of the egg! We are told that the ectodermic invaginations which give rise to the "nares" become "continuous with the mesenteron" (p. 335). The description of the development of the lungs (p. 334), together with the figure copied from Wiedersheim, refer to the mammal, and not to the frog. In the account of the development of the body-cavity (p. 335), it is said that the latter, "extended upwards through the lateral mesoblastic plates, nearly meets in the middle line beneath the notochord, and so pinches the alimentary canal with its glands into the body cavity"; and on page 333 it is stated that the notochord "pierces the mesoblast and divides it into right and left halves." The numbering of the *five* aortic arches given in Fig. 225, and that of the *three* mentioned in the text is incorrect (p. 336). We learn that metamorphosis begins soon after the development of the gills (p. 336). The account of the development of the urinogenital ducts on p. 338 is quite incorrect as applied to the frog. In Chapter XVIII. one gathers that the processes of digestion in all the Cœlomata are quite similar to those which occur in the higher forms, which are then briefly described.

Even if we accept the author's dictum that "he will know a good deal of botany who knows Chara and Lamium thoroughly," and give him full credit for having worked up some parts of the subject practically, we must remind him that a wider knowledge than this implies is advisable before attempting to write a book on general biology. After reading the preface and introduction, one is led to expect that the high ideal set up by the author as regards actual personal observation would at any rate have led him to examine carefully and accurately all the types described; it is very disappointing to find that this has not been the case. In conclusion we venture to repeat Darwin's advice as quoted on p. 200 of this book: "Give full play to your imagination, but rigidly check it by testing each notion experimentally."

W. N. P.

VAN'T HOFF'S "STEREOCHEMISTRY."

Stéréochimie. Nouvelle Edition de "Dix Années dans l'Histoire d'une Théorie." Par J.-H. van't Hoff. Rédigée par W. Meyerhoffer. (Paris: Georges Carré, 1892.)

THE second edition of this work was very fully reviewed in these columns in 1887 (vol. xxxvii. p. 121), and we will therefore content ourselves with noticing briefly the new matter contained in the present edition.

We must, however, premise that the stereochemistry of the carbon compounds is based on the assumption that the four monad atoms or groups satisfying the four affinities of a carbon atom are situated at the solid angles of a tetrahedron, the centre of which is occupied by the carbon atom itself, and on the allied conception of the "asymmetric" carbon atom—"asymmetry" arising when the four attached atoms or groups are dissimilar, in which case two enantiomorphic arrangements are possible for any given set of four such atoms or groups (see the notice already referred to). In the first French edition, which bore the title "La Chimie dans l'Espace," the author discussed the greatly increased possibilities of isomerism to which this new theory led. Since then chemists have used the theory as a guide in the search for cases of isomerism, and numerous new isomeric compounds have been discovered, the existence of which could not have been predicted as long as the old constitutional formulæ written in one plane were employed. The history of this branch of organic chemistry has, during the past seven or eight years, been one continuous triumph for the theory. One of the most striking proofs of the value of these stereochemical views is to be found in Emil Fischer's well-known researches on the sugar group. In the group of the glucoses of the aldehyde-alcohol type, for example, the presence of four asymmetric carbon atoms has to be assumed, and the theory predicts the existence of no fewer than sixteen isomerides with a normal carbon chain, as compared with the one form admissible under the older view. Several of the predicted forms have been prepared, and the relative distribution of the positive and negative asymmetric carbon atoms within the molecule has been determined by E. Fischer. This and other work confirmatory of the theory, is described and discussed in the present volume.

The theory of the asymmetric carbon atom owes its origin to the difficulty of otherwise explaining the optical rotatory power of various organic compounds. Quite recently, P. A. Guye has suggested that the numerical value of this optical rotatory power is dependent upon the relative masses of the substituting atoms or groups attached to the asymmetric carbon atom, and that if two of the four different substituting radicles are of equal mass the rotatory power will cease. He was unable to verify this view in all strictness, since, in the cases of this kind which he studied, such as that of methyl-ethyl-aldehyde $(C_2H_5)(CH_3)\,CH\,(COH)$, in which $C_2H_5 = COH = 29$, there was optical activity. The probable explanation is, that, as suggested by Guye, not only the masses of the groups, but also the interatomic distances, of which the atomic volume is a measure, come into play here. However, by varying the weight of a given group attached to an asymmetric carbon atom—thus, by substituting successively different homologous radicles—it was found possible to produce a concomitant variation in the rotatory power of the compound, to make it increase or decrease at will, and even to change its sign. This variation is shown in ascending the series of the esters of tartaric acid and its di-acetyl and di-benzoyl derivatives. But whereas the weight of the alkyl-group in the esters determines the amount of the rotatory power, no such influence can be perceived in the case of the metallic salts of tartaric acid, all of which display in solution the same rotatory power, irrespective of the atomic weight of the metal. The clue to this anomaly is furnished by the electrolytic dissociation theory of Arrhenius, according to which the dissolved salts are present in the form of their dissociated ions, so that, in the case of the dissolved metallic tartrates, it is the ion $CO_2(CH.OH)_2CO_2$ which is alone responsible for the rotation. Arrhenius's theory thus receives striking confirmation from an unexpected quarter.

The subject of compounds containing closed chains is fully discussed in the present edition, and the "cis" and "trans" isomerism discovered by von Baeyer is described.

The relative position of the substituting groups in the stereo-isomerides is also discussed.

The concluding chapter deals with the stereochemistry of nitrogen—a question which had not emerged when the previous edition was published. Some of the information given under this heading is rather meagre; but doubtless the omissions are intentional and they are largely compensated for by a very complete bibliography of the subject.

The work is in every sense authoritative, and we cordially recommend it to all interested in the most recent developments of organic chemistry.

F. R. J.

OUR BOOK SHELF.

Die Fossile Flora der Höttinger Breccie. By R. von Wettstein. With 7 plates. (Vienna: Imperial Printing Office, 1892.)

THE Höttinger Breccia is a formation about 50 feet thick in the neighbourhood of Innsbrück, and situated about 1200 metres above sea-level. The upper part consists of about 35 feet of coarse conglomerate, with fossils chiefly confined to a bed some 3 feet thick, while the remainder is occupied by alternating beds a foot or two in thickness of white or reddish sandstones and breccias, which are for the most part very fossiliferous. It has been well known to collectors of fossil plants for upwards of thirty years, and though at first regarded as of tertiary age, is now uniformly recognised as quarternary, possibly inter-glacial, or more probably post-glacial. The lower part is characterised by the occurrence of many herbaceous plants, such as the violet, strawberry, coltsfoot, Prunella, &c., which are replaced above to some extent by *Cornus sanguinea*, *Rhamnus Frangula*, an alder, willow, &c., indicating, perhaps, a change in the forest growth without necessarily implying any considerable interval of time. The flora is almost wholly of existing species, and in the main does not differ essentially from that which might be found in a similar situation at the present day; but six of the species no longer flourish at such an altitude, and a few others, like the box, are absent in Northern Tyrol,

while there are also indications in the relative sizes of the leaves of others that the climate was milder. Perhaps the Alps were less elevated and the sea nearer at the time, but interest is given to the problem by the undoubted presence of *Rhododendron ponticum*, which at present only flourishes in a much warmer climate far to the east, but, from its discovery in other localities, was evidently thoroughly indigenous in the Alps. The author regards the flora as a relic of the "steppe-flora" which then spread over the greater part of Europe, and of which numerous traces still exist, especially in Switzerland and Lower Austria, where plants of Oriental facies, such as the yew, box, holly, Ephedra, Sumach, hornbeam, feather-grass, maidenhair, &c., are its lingering remains.

The work is carefully prepared, doubtful determinations, except in the case of the Arbutus and a new buckthorn allied to *Rhamnus latifolia* of the Canaries, are eschewed, and the photographic illustrations, pencilled over by the artist, are extremely satisfactory. J. S. G.

Observational Astronomy. By Arthur Mee, F.R.A.S. (Cardiff: Daniel Owen and Co., 1893.)

THIS small book should serve the purpose for which it is issued; the object being to provide the beginner with an inexpensive treatise to enable him to become familiar with and interested in the practice of observational astronomy. For this reason the author limits himself to the purely descriptive side of astronomy, dealing with the sun, planets, comets, and meteors, giving numerous references where necessary. Short chapters are given on eclipses, transits, occultations, and "the sidereal firmament," the latter treating of double and coloured stars, &c. The chapter on the telescope contains many practical hints, besides numerous woodcuts, while that devoted to the moon is very pleasant reading, and gives a good account of the more general features. The illustrations, as will be gathered from the above, are very numerous, many of them being from the pen of the author himself. With respect to these, we must add that the one given on p. 72 of the Orion nebula does not remind us of the most beautiful object in the heavens, while on p. 66 Donati's comet is depicted minus the two long streamers which made this object so striking. The book concludes with a short obituary of the Rev. T. W. Webb and an appendix containing brief contributions from Denning on comets and meteors, Gore on variable and temporary stars, Seabroke on double star measurement, and a few others.

W. J. L.

Mechanics and Hydrostatics for Beginners. By S. L. Loney, M.A. (Cambridge University Press, 1893.)

THIS is the latest addition to the series of elementary text-books recently launched by Mr. Loney. The same high standard of excellence is maintained, and the author must again be congratulated on his efforts to place in the hands of a beginner a book which will give him correct ideas of the laws and principles which are included in a study of mechanics.

It consists of three parts, statics, dynamics, and hydrostatics, each part containing the usual chapters. If the reader should fail to understand the chapter on the laws of motion, he must attribute it either to his want of ability or the nature of the subject, for we fail to see how the author could improve his remarks on this part of the subject. We are glad to observe that the words "rate of change" find their way into the statement of the second law, for its definiteness is increased thereby. More than the usual care appears to have been devoted to the selection of suitable examples; some of them are exceptionally good, and thus add to the usefulness of the book. Occasionally the trigonometrical ratios are used, but their definitions will be found in the appendix; we are afraid, however, that the suggestion that their values for certain angles should be committed to memory is not a wise one. G. A. B.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Glacier Theory of Alpine Lakes.

THE letter of the Duke of Argyll against the theory of the formation of alpine lakes by glacial action shows such an amount of misconception of the theory itself, and so completely ignores the great weight of evidence in its favour, that a few words on the other side seem desirable.

The Duke says that glaciers "do not dig out," do not "act like a ploughshare," but, when moving down a slight incline do "scoop," as well as rub down and abrade. No observer of glaciers has ever stated, so far as I know, that they do "dig out," and it is equally erroneous to say that they "scoop," for that implies that it is the end of the glacier that acts. But the end is its weakest point, where it is melting above and below, and where consequently it can do practically nothing. The whole action of a glacier is a grinding action, and its grinding power is greatest where it is thickest, and where, consequently, it presses on the rocks with the greatest weight. The result of this grinding is seen in the muddy stream issuing from all existing glaciers; while the well-known "till" is the product of the rock grinding mill of ancient glaciers and ice-sheets.

Notwithstanding the Duke's disbelief in ice-sheets I venture to think that their former existence has been demonstrated both in Scotland and Ireland; but leaving this point, I wish to make a few remarks on the extreme inadequacy of the earth-movement theory to account for the facts. In the first place it is certain that no alpine lake can possibly have a long life, geologically speaking. In the course of a few thousands of years, certainly in less than a hundred thousand, all alpine lakes would be filled up by the sediment brought into them. It follows that all the existing lakes must have been formed about the same period, and that, geologically, a very recent one, and corresponding approximately with that of the well-known glacial epoch. But if these lakes were all formed by earth movements, either just before the glacial epoch came on, or during its continuance, or afterwards we have to explain the remarkable fact that such movements only occurred within the limits of glaciation, never beyond those limits. In Wales, Cumberland, and Scotland, in the Alps, in Scandinavia, in Finland, in the northern United States and Canada, in Mongolia and Thibet, in Tasmania and New Zealand, we have thousands of rock-basin lakes, amid palpable signs of glaciation. But the moment we pass beyond the glaciated districts, mountain lakes abruptly cease. There are hardly any in Spain, none in the Great Atlas, none in Sardinia or southern Italy, except in the volcanic areas and away from the mountains, none in any of the West Indian islands with their fine mountain-ranges, none in the peninsula of India or in Brazil. And there is exactly the same distribution of fiords. We have them in Norway, in West Scotland, in Alaska, in South-West America, and in New Zealand, all characterised by deeper water within than at their outlets, and all in glaciated countries, but nowhere else in the world.

Now it is simply impossible to believe that at a very recent period there should have been earth-movements of such a character as to produce lakes, but always in glaciated districts and never beyond them, unless the movements were a result of the glaciation. This has not, I believe, been yet suggested; but, in view of the modern theory that any considerable loading of the surface produces subsidence, it is at least a possible explanation. But there are some important facts that seem more in favour of the grinding out of the lake-basins by the enormous weight of ice accumulated over their sites during the height of the ice-age. Looking at a geological map of the Alps it will be seen that most of the lakes are more or less bordered by tertiary or secondary rocks. Lakes Annecy and Bourget are in miocene

and eocene; the lake of Geneva on the north side is miocene or jurassic; the lake of Neuchatel, miocene; lakes Thun and Brienz, eocene or jurassic; lake Lucerne, eocene and miocene; lakes Zug and Zurich in miocene; lake Constance miocene; lake Maggiore is mostly in gneiss, but it is very suggestive that it is here comparatively shallow, but becomes suddenly deeper and reaches its maximum depth in its lower portion where it is bordered on the east by the jurassic beds; lake Como also has its greatest depth in triassic rocks, the upper portion, where gneiss prevails, deepening gradually southward as in a submerged valley. Equally suggestive is the fact that in the eastern Alps of Tyrol and Carinthia, where gneiss, porphyry, and the older stratified rocks prevail, and where glaciers are not now so extensive, there are hardly any lakes, except on the northern borders, where a considerable number occur in eocene, cretaceous, jurassic, or triassic formations.

These various facts as to the distribution of alpine lakes—their almost total absence in all parts of the world outside of glaciated districts, and within glaciated districts their prevalence in the newer and more easily denuded rocks—are what have to be explained by the advocates of the theory of earth-movements, and this, so far as I am aware, they have never attempted to do. Equally important, and equally difficult to explain on the earth-movement theory, is the fact that alpine lakes are almost always situated just at those spots where, by means of converging valleys, the glaciers would become heaped up and attain their maximum thickness, or where there is good evidence that they have been very thick; and it is the grinding power of this enormous weight of ice, acting differentially as regards the softer and harder rocks, that has worn out hollows in pre-existing valleys now occupied by lakes. In almost every case, too, it will be seen that there is a constriction or narrowing of the valley towards or beyond the lower end of the lake, which, by preventing the free escape of the ice, has increased its thickness and grinding power.

In the presence of such important series of facts as those here referred to, mere opinions, or even small and detailed cases of difficulty, can have no weight; but there is yet another consideration, which most geologists will admit is antagonistic to the earth-movement theory. The whole tendency of geological observation is in favour of the usually very slow rate of earth-movements, while it is equally in favour of the comparatively rapid action of denudation by running water. But in order that earth-movement could form a lake, it would be necessary that the rate of elevation or depression should be so great that the river could not keep pace with it by cutting down its channel; and, considering that all the rivers in question are rapid mountain streams carrying great quantities of sediment, this will be admitted to be a very improbable supposition. But when we add to this the still greater improbability that such rapid earth movements have occurred in scores and hundreds of cases, all at about the same time, geologically speaking, and all just in those spots where it can be shown that during the glacial period ice must have accumulated, and where the rocks were of such a character as to admit of being ground away; and yet further, that no similar earth movements producing similar results have recently occurred in any part of the globe beyond the limits of glaciation, the whole assumption becomes so hugely improbable as to render the theory of lake-formation by ice-grinding easy in comparison.

Sir Charles Lyell considered that the gravest objection to the glacial-erosion theory was the entire absence of lakes where they ought apparently to exist; and he instanced the valley of Aosta and the Dora Baltea, the glacier of which produced the enormous moraines of Ivrea. The valley of the Rhone above Martigny may be adduced as another example of the absence of lakes where they might be expected. But this kind of difficulty will apply to many other valleys, and can only be answered by general considerations. In both these cases the valleys are comparatively broad and open, and have a rather rapid descent. It is probable, therefore, that the ancient glacier in both was of a nearly uniform thickness, so that its wearing action on the floor of the valley would be tolerably uniform. To produce a lake we require essentially a differential action. There must be much more rapid degradation in one part than in another, due either to greater ice-accumulation or to softer rocks in one part than in another. In both the valleys referred to there is much uniformity in the rock-formations throughout, and even if some lakes or chains of lakes had been formed, the enormous amount of debris still brought down may well have filled up and altogether obliterated them. The absence of lakes in certain valleys cannot be considered an argument of any value until it is ascertained by borings that none have been formed and filled up again. It must also be shown that the whole conditions are such as to produce that amount of differential grinding down, without which no lake can be expected to have been formed.

It certainly seems to me that all the facts, all the probabilities, all the converging lines of evidence, are in favour of the glacial theory, to which the only serious objection is the assumption that glaciers cannot move uphill. But that they can do so, and have done so, is now admitted by most students of glacier-motion. Mr. Jamieson, and other Scotch geologists, have proved that glaciers, over 2000 feet thick, have travelled up lateral valleys, and up the slopes of many hills and mountains; and when we consider that the Rhone glacier was 5000 feet thick just above the lake of Geneva, and more than 2000 feet thick where it abutted against the Jura, we can have no difficulty in admitting that it might have travelled up the very gentle slope of the lake bottom, which appears to be less than 100 feet in a mile in its steepest parts. ALFRED R. WALLACE.

Waves as a Motive Power.

HAVING frequently observed the swimming motions of the fishes in our Aquarium—and occasionally of porpoises in the open sea—I have tried to make use for propelling boats of the same principle of locomotion, as exemplified particularly in the tail-fin.

I fixed a fin (blade) of elastic material like a helm to the end of a canoe; moving that fin laterally to and fro, the same went forwards. I have since learned that this "motor" was used already twenty-five to thirty years ago by Ciotti, a Sicilian; it is of course only an exact version of the method of sculling with one oar, familiar to all boatmen. Whilst trying my canoe and models of boats I soon became convinced that a boat ought to move forward if elastic fins are fixed to it, directed backwards, in such a manner that their flat sides are pressed against the surrounding water, when the boat rolls and pitches. The elastic fins, whilst overcoming the resistance of the water, curve like the fins of a fish, driving the water backwards and consequently pushing the boat forwards.

The canoe was provided with two horizontal fins at the stern and two vertical ones at the keel, total surface 0·2 square metres; speed against rather sharp wind and waves estimated at 25 metres per minute. I was unable to take exact measurements, as the canoe was accidentally sunk before the experiment was complete.

I then provided another boat, three metres long, at each of the two pointed ends with a horizontal fin (later on two), and at the keel with two vertical fins; these were all made of steel sheet, 1 – 0·8 mm. thick, subsequently replaced with aluminium bronze. The boat covered, against a gentle sea and wind, the distance of 900 metres in 25 minutes. Putting the fins obliquely the boat turned towards the right or left; directing one group of the fins forward, and another of equal surface backward, their action was paralysed, and in similar manner it was easy to make the boat turn round on the spot or to move backward.

The changing of the surface of the fins (0·3 to 0·6 square metres) caused very little difference in the speed produced. The same movements of the boat take place if the rocking is caused artificially.

I undertook a series of trials, in which I wish to acknowledge with thanks the kind assistance of Mr. Nelson Foley. The first result was that the *rolling* yields so little power, (very little energy being sufficient to prevent rolling,) that the vertical fins as a source of power may be nearly neglected in the calculations.

As to *pitching*, the power resulting from the action of the waves against gravity is proportioned to (weight of boat with crew) × (number of undulations) × (height of waves). But only a small portion of the energy developed in moving the boat up and down acts upon the fins (surface of boat in water-line three square metres, surface of fins 0·3 to 0·6 square metres), and of this remaining available force a considerable portion is lost by the low efficiency of the fins. Supposing, for the sake of argument, the efficiency to be 25 per cent., the propelling capacity in a moderate sea works out to the fraction of a man's power.

Considering these circumstances it seems doubtful, even with

considerable rocking and using boats of more advantageous forms than mine, if it will be possible to have a much higher speed than 2000 metres per hour. It appears also that the available force will be hardly sufficient to struggle successfully against strong winds and currents.

I do not therefore prognosticate too confidently any practical value to the motor, but should be very glad if some of your readers would inform me as to any similar experiments which may already have been made. H. LINDEN.

Zoological Station, Naples, February 19.

Blind Animals in Caves.

As a reader of Mr. Herbert Spencer's writings and a disciple of his, I shall be very glad to lift Prof. Lankester's glove. In the first place I would point out that the process he describes is not natural selection in the ordinary sense; natural selection is the death of the unfit and the survival of the fittest. In the suggested process neither the animals with perfect eyes, nor those with imperfect, are destroyed in the struggle for existence; they are simply segregated. But this is of minor importance. The question is whether there is any foundation for the hypothesis suggested.

Prof. Lankester supposes that the individuals born with defective eyes have remained in the dark places, while those with perfect eyes have followed the glimmer of light and escaped. But he has overlooked the fact that blind cave-animals are *born or hatched at the present day with well-developed eyes.* It is clear, therefore, as in every other case to which the law of recapitulation applies, that the variations to which the evolution is due occurred at a comparatively late period in the life of the individual. Why did not all the individuals escape when they were young, and could still see without spectacles? When the imperfection of the eyes did occur, what ground is there for assuming that it was a congenital variation? It seems to me perfectly certain that it was a deterioration of the eyes caused by the fact that the individual had lived in the dark all its life. In short, I hold that the law of recapitulation in development, the law of metamorphosis, or biogenetic law, as Haeckel called it, is itself a sufficient proof of the inheritance of acquired characters. This argument has never been met or even considered by any of those who talk of congenital fortuitous variations without defining them.

The evidence for the statement I have made is, I confess, not quite complete, but it is sufficient for my present purpose. In Semper's "Animal Life," p. 80, there is an account of *Pinnotheres Holothuriæ*, based on the author's direct observations. This species lives in the respiratory trees of Holothurians, and in the adult the eyes are degenerate and invisible on the exterior of the animal. The young is hatched as a zoæa with perfect typical eyes; even when it enters the host it retains its eyes, but afterwards the eyes degenerate and become covered over by the carapace. In the common mole, to take an instance among mammals, the optic nerves are degenerate in the adult, so that there is no connection between eye and brain; but in the embryo both eyes are connected with the brain by well-developed optic nerves. I am not at present acquainted with any observations on the young of Proteus, or the blind fish Amblyopsis, or the blind Crayfish of the mammoth cave, but I am quite confident that the young in all these cases have relatively well-developed eyes. At any rate Prof. Lankester to support his theory must prove that they are blind from the beginning; for if they are not then it is clear that the variations which we have to consider took place during the life of the individual living in the dark, and consequently the support of Prof. Lankester's suggestion vanishes. Prof. Lankester again writes of the deep sea as though it were as destitute of light as the mammoth cave, or the subterranean home of the Proteus, but this is notoriously not the case. With regard to fishes, Dr. Günther says that below the depth of 200 fathoms small-eyed fishes as well as large-eyed occur, the former having their want of vision compensated for by tentacular organs of touch, whilst the latter have no such accessory organs, and evidently see only by the aid of phosphorescence; in the greatest depths blind fishes occur with rudimentary eyes, and without special organs of touch. Dr. Günther mentions fifty-one species of fishes living at depths beyond 1000 fathoms, and among these only three *Aphyonus gelatinosus*, *Typhlonus nasus*, and *Ipnops Murrayi* are blind. It is, I think, sufficiently evident that the biology of the deep sea is quite different from that of subterranean caves or habitats. J. T. CUNNINGHAM.

Plymouth, February 27.

BESIDES panmixia and emigration of the more perfect-eyed individuals, as explained by Prof. E. Ray Lankester, allow me to suggest another cause for the dwindling of the eyes in cave-dwelling animals.

Prof. Weismann says that the degeneration "can hardly be of direct advantage to the animals, for they could live quite as well in the dark with well-developed eyes." I submit, however, that in a place permanently dark the eye is not merely useless, but, as a delicate and vulnerable part, it becomes a positive source of danger to the animal. No longer helping the creature to avoid obstacles or danger, it is, in proportion to its size, exposed to injury, destructive inflammation, and the attacks of parasites in a manner which must not seldom lead to the death of the individual. As other senses become more acute, and the eye recedes, this danger diminishes, and when the eye has become a mere rudiment, "hidden under the skin," its presence ceases to be a disadvantage, and so degeneration does not proceed to complete suppression.

It is a wonder that Mr. H. Spencer should have overlooked Prof. Lankester's explanation, for the English editor of Prof. Weismann's fifth essay has not failed to call attention to it.

Mirfield, February 27. A. ANDERSON.

[Darwin has himself drawn attention, in regard to burrowing animals, to the conditions pointed out in the above ("Origin of Species," 6th edition, p. 110).—ED.]

Foraminifer or Sponge?

I AM glad to find that Mr. Pearcey agrees with me in regarding *Neusina Agassizi*, Goës, as identical with *Stannophyllum zonarium*, Hæckel. But with respect to its systematic position I do not as yet see sufficient reason to differ from Prof. Hæckel in regarding it as a sponge, although I have never observed flagellated chambers and cells any more than he. The large masses of foreign bodies always present in this organism offer very serious difficulties in sectionising it, and as long as we are not absolutely certain about its cellular structure we are justified in thinking with Hæckel that general appearance and the presence of oscula, pores, subdermal cavities, horny skeleton, &c., are sufficient to characterise the form as a sponge.

Mr. Pearcey mentions six genera of Foraminifera which he thinks approach closely to *Stannophyllum*. I am sorry I cannot see much similarity. The chitinous lining in the tube-like body of some Foraminifera certainly bears not the slightest resemblance to the distinct fibrous stroma of *Stannophyllum*, which reminds me much more of the filaments of the true horny sponge *Hircinia*. If anything tells in favour of Mr. Pearcey's view, it is the concentric lines of *Stannophyllum*, which recall the foraminiferal rather than the sponge type of growth.

The final decision of this question can of course only be expected from an examination of the cell-structure.

University College, Liverpool, February 25. R. HANITSCH.

A Magnetic Screen.

DURING the last vacation St. John's College, Oxford, has been lit with the electric light, and a transformer of the dynamomotor type, weighing over seven tons, has been placed within about sixty feet of the electrical testing room of the Millard Laboratory, which is furnished with several reflecting galvanometers. I greatly feared that the instruments would suffer much from the magnetic field of the large transformer. When it was found that no other space could be given up for the machine, I devised a method of construction which the Oxford Electric Lighting Company very kindly carried out for me when building their dynamo house. My method is to construct a wall of scrap iron round the three sides of the dynamo nearest to our laboratory. The iron wall is about eight inches thick, and is made by building two brick walls parallel to one another, and filling the interspace with scrap-iron; a delicate magnetometer used for testing the field at unprotected and protected points equidistant from the magnets, when the machine is in action and not so, shows that the iron wall is an effective barrier to the magnetic influence. I venture to make known this method of shielding off a magnetic field, because in these days of electrical invasion it may be of use in protecting physical instruments from being seriously disturbed, and rendered useless for any but the roughest determinations. FREDERICK J. SMITH.

Trinity College, February 28.

ON ELECTRIC SPARK PHOTOGRAPHS; OR, PHOTOGRAPHY OF FLYING BULLETS, &c., BY THE LIGHT OF THE ELECTRIC SPARK.[1]

II.

GOING back now to the photographs, the next one was taken with the view of illustrating the effect on the inclination of the waves of the velocity of the bullet. In this case the bullet was aluminium; it was only one-seventh the weight of the regulation bullet. In consequence of its lightness it travelled about half as fast again as the ordinary bullet (not $\sqrt{7}$ times as fast as it would have done if the pressure of the powder-gases had been the same in the two cases), and in consequence of the higher speed the inclination of the waves is still greater than in the previous case. Further, in this case the bullet was made to pierce a piece of card shortly before it was photographed. The little pieces that were cut out were driven forward at a high speed, but, being lighter than the bullet, they soon lost a large part of their velocity; they had in consequence lagged behind when they were photographed, but though travelling more slowly (they were still going at more than 1100 feet a second) they yet made each its own air wave, which became less and less inclined as the bits lagged more and more behind; each, moreover, produced its own trail of vortices like that following the bullet. The well-known fact that moving things tend to take the position of greatest resistance, to avoid the effect of which the bullet has to be made to spin, is also illustrated in the photograph. The little pieces that are large enough to be clearly seen are moving broadside on, and not edgeways, as might be expected.

In order to illustrate the other fact that the angle of the waves also depends on the velocity of sound in the gas, I filled the box with a mixture of carbonic acid gas, and the vapour of ether, a mixture which is very dense, and through which sound in consequence travels only about half as fast as it does in air, and which will not explode or even catch fire when an electric spark is made within it, or directly act injuriously upon the photographic plate. The increased inclination of the waves is very evident in Fig. 10.

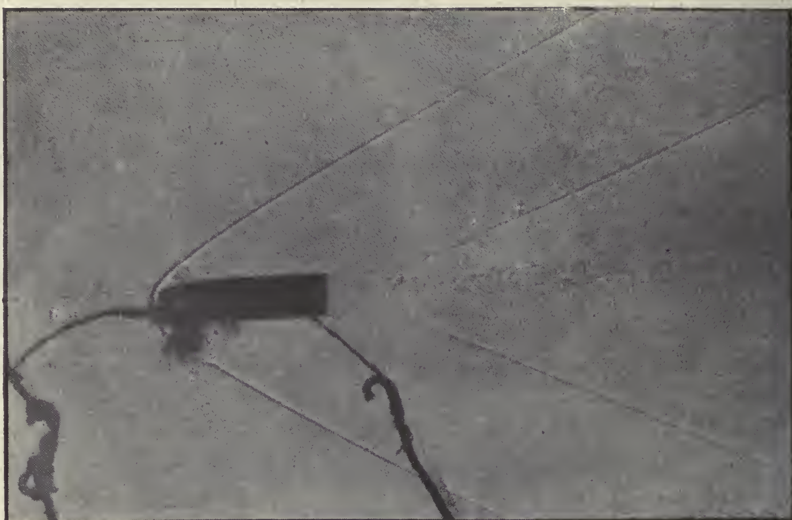


FIG. 10.

These waves, revealed by photography, have a very important effect on the flight of projectiles. Just as in the case of waves produced by the motion of a ship, which, as is well known, become enormously more energetic as the velocity increases, and which at high velocities produce as a matter of fact an effect of resistance to the motion of the ship of far greater importance than the skin friction, so in the case of the air waves produced by bullets; in its flight the resistance which the bullet meets with increases very rapidly when the velocity is raised beyond the point at which these waves begin to be formed. This being the case, I have thought it might be interesting to see whether the analogy between the behaviour of the two classes of waves might be even nearer than has already appeared, and on turning to the beautiful researches of Mr. Scott Russell, published in the Report of the British Association for the year 1844, in which he gives a very full report on water waves and their properties, I found that he had made experiments and had given a diagram showing what happens when a solitary wave meets a vertical wall. The wave, as would be expected, is, under ordinary conditions, reflected perfectly, making an angle of reflection equal to the angle of incidence, and the reflected and incident waves are alike in all respects. This continues to be the case as the angle gets more and more nearly equal to a right angle, *i.e.* until the wave front, nearly perpendicular to the wall, runs along nearly parallel to it. It then at last ceases to be reflected at all. The part of the wave near the wall instead gathers strength, it gets higher, it therefore travels faster, and so causes the wave near the wall to run ahead of its proper position, producing a bend in the wave front, and this goes on until at last the wave near the wall becomes a breaker.

In order to see if anything similar happens in the case

[1] Lecture delivered at the Edinburgh meeting of the British Association by C. V. Boys, F.R.S. Continued from page 421.

of air waves, I arranged the three reflecting surfaces of sheet copper seen in Fig. 11, and photographed a magazine rifle bullet when it had got to the position seen. Below the bullet two waves strike the reflector at a low angle, and they are perfectly reflected, the dark and the light lines changing places as they obviously ought to do. The left side of the V-shaped reflector was met at a nearly grazing incidence; there there is no reflection, but, as is clear on the photograph, the wave near the reflector is of greater intensity, it has bent itself ahead of its proper position as the water wave was found to do, but it cannot form a breaker, as there is no such thing in an air wave. The same photograph shows two other phenomena which are of interest. The stern wave has a piece cut out of it by the lower reflector, and bent up at the same angle. Now if a wave was a mere advancing thing the end of the bent-up piece would leave off suddenly, and the break in the direct wave would do the same. But according to the view of wave propagation put forward by Huygens, the wave at any epoque is the resultant of all the disturbances which may be considered to have started from all points of the wave front at any preceding epoque. The reflector, where it has cut this wave, may be considered as a series of points of disturbance arranged continuously in a line, each, however, coming into operation just after the neighbour on one side and just before the neighbour on the other. The reflected wave is the envelope of a series of spheres beginning with a point at the place where the wave and the reflector cut, growing up to a finite sphere about the end of the reflector as a centre; beyond this there are no more centres of disturbance, the envelope of all the spheres projected upon the plate, that is, the photograph of the reflected wave, is not therefore a straight line leaving off abruptly, but it curls round, as is very clearly shown, dying gradually away to nothing. The same is the case, but it is less marked, at the end of the direct wave near the part that has been cut out.

The other point to which I would refer is the dark line between the nose of the bullet and the wire placed to receive it. This is the feeble spark due to the discharge of the small condenser which clearly must have been on the point of going off of its own accord. The feeble spark precedes—or is to all intents and purposes simultaneous with, it cannot follow—the main spark which makes the photograph. The feeble spark heated the air, and the light from the main spark coming through this line of heated air was dispersed, leaving a clear black shadow on the plate. One spark casts a shadow of the other. Now it is evident that if the spark at the nose of the bullet had followed instead of having preceded the main spark by even so much as a three-hundred-millionth of a second, the time that light took to travel from one to the other, it would not have been able to cast a shadow. We have the means of telling, therefore, which of two sparks actually took place first, or perhaps the order of several, even though the difference of time is so minute. Perhaps this method might be of some use in researches

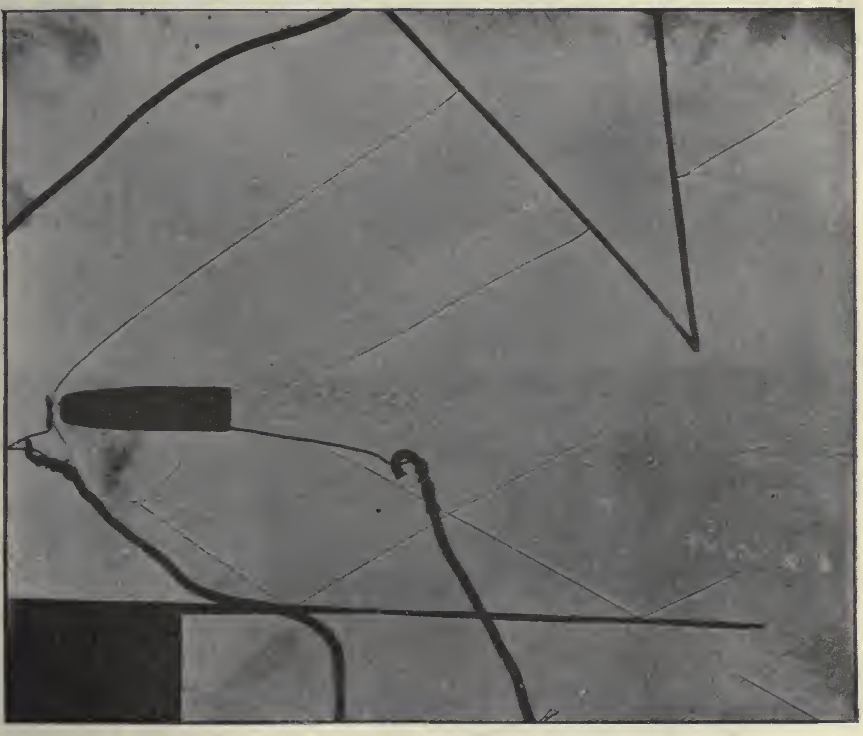


FIG. 11.

now attracting so much interest in connection with the propagation of electrical waves.

On returning to the non-reflection of the air wave in the upper part of the figure we have here, I imagine, optical evidence of what goes on in a whispering gallery. The sound is probably not reflected at all, but runs round almost on the surface of the wall from one part to another.

We are now in a position to see how the reflection or non-reflection of air waves produced by a passing bullet, when they meet with some solid body, may produce a practical result which might be of importance in some cases. Suppose a bullet to be passing near and parallel to a wall. Then if the velocity of the bullet and its distance from the wall are such that the head wave meets the wall at an angle at which it can be reflected, especially, as in the case of Fig. 11, if the reflected ray can only return into the path of the bullet after it has gone, then no influence whatever can be exerted upon the bullet by its proximity to the wall. If, however, the head wave would, if undisturbed, meet the wall at such an angle that it could not be reflected, as for instance, in Fig. 12, when the head wave can be reflected by neither of the walls between which the bullet is passing, obviously the wave will become stronger and the resistance which it offers will, I imagine, become greater, and if in this case the upper plate be removed this extra resistance will be one-sided and must tend to deflect the bullet. This is quite distinct from the well-known effect of a bayonet upon the path of a bullet; when a bayonet is fixed the rush of powder gases between the bullet and the bayonet is quite sufficient to account for the deflection which every practised marksman allows for.

I have devised a method by which a problem of some difficulty, about which authorities are, I believe, by no means in accord, may be solved with a fair degree of certainty. The problem is this, to find what proportion of the velocity of a bullet is given to it after it has left the barrel, or, what comes to the same thing, to find the position in front of the barrel at which the speed is a maximum. The cause of this is evident. When the bullet has left the muzzle the imprisoned powder gases, under enormous pressure, rush out, making a draught past the bullet of the most tremendous intensity tending obviously to drive it forward. While this draught does most assuredly hurry the bullet on its forward course, it does not tend to make it spin round any faster. Now if the bullet were not hurried on at all after it left the muzzle it would, travelling as in a screw of the same pitch all the way from the breach of the rifle up to the point at which it is photographed, have turned round a certain number of times which depend upon the distance travelled and the pitch of the screw. If, however, the longitudinal motion is hurried and the rotational is left unaltered the pitch will be lengthened outside the barrel and the rotation will have been less for any position than it would have been if the bullet had not been accelerated in this way. If, therefore, we can find to what extent the bullet has turned actually at the place at which it has been photographed, we can find the apparent rotational lag and so working backwards get a measure of the velocity acquired after leaving the muzzle. In order to accomplish this I drilled a series of holes transversely through the bullet, each one at an angle to the previous one, the whole series being such that to whatever extent the bullet had twisted, one at least, and perhaps two, would allow the light of the spark to shine through it upon the photographic plate. Then from the photograph it is easy to see through which hole the light shone, and knowing in what position this was in the breach, it is easy to find what fraction of half a turn over or above any whole number of half turns the bullet has twisted. Strictly the measure should be made at different distances to eliminate all uncertainty, but the only shot I have taken was sufficient to show that there was a rotational lag equivalent, according to the measure made by Mr. Barton, to something under a two per cent. acceleration outside the barrel. I do not attach any importance to this figure; the experiment was made with a view to see if the method was practicable and this it certainly is. I would recommend, where accuracy is required, that having found as above about how much the

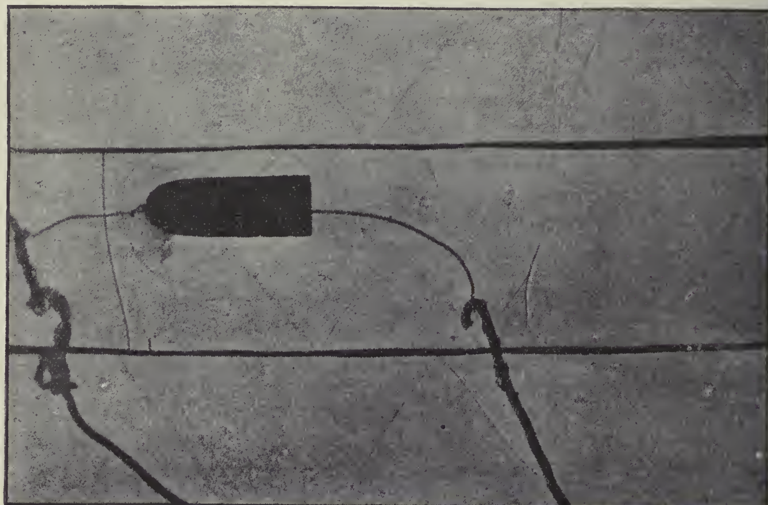


FIG. 12.

bullet has turned, that a second bullet should be drilled with a series of holes at about the corresponding position differing very slightly from one another in angular position, so that several would let the light through and thus give a more accurate measure of the rotation.

There is a point of interest to sportsmen which has given rise to a controversy which the spark photographs supply the means of settling. The action of the choke bore has been disputed, some having held that the shot are made to travel more compactly altogether, while others, while they admit that the shot are less scattered laterally, as may be proved by firing at a target, assert that they are spread out longitudinally, so that if this is the case the improved target pattern is no criterion of harder hitting, especially in the case of a bird flying rapidly across the direction of aim.

shot is filled with air waves of the greatest complexity. They are not due to the cause already explained, but are, I believe, formed by the imperfect mixture of air with powder gases still accompanying the shot. The imperfect mixture of the two gases causes light to be deflected in its passage, thus producing striæ just as at the first mixing of whisky and water, striæ are seen (sometimes attributed to oil !), which disappear when the mixture is complete. I would mention, for the benefit of any one who may be tempted to continue these experiments, that a pair of wires such as are found to do so well when bullets have to be caught are not suitable, as one is sure to be shot away before such a bridge of shot is made between them as will allow a spark to pass. However, by using thick copper wires, one bent in the form of a screw, with the other along the axis, no such failure can occur and every shot that I have taken in this way

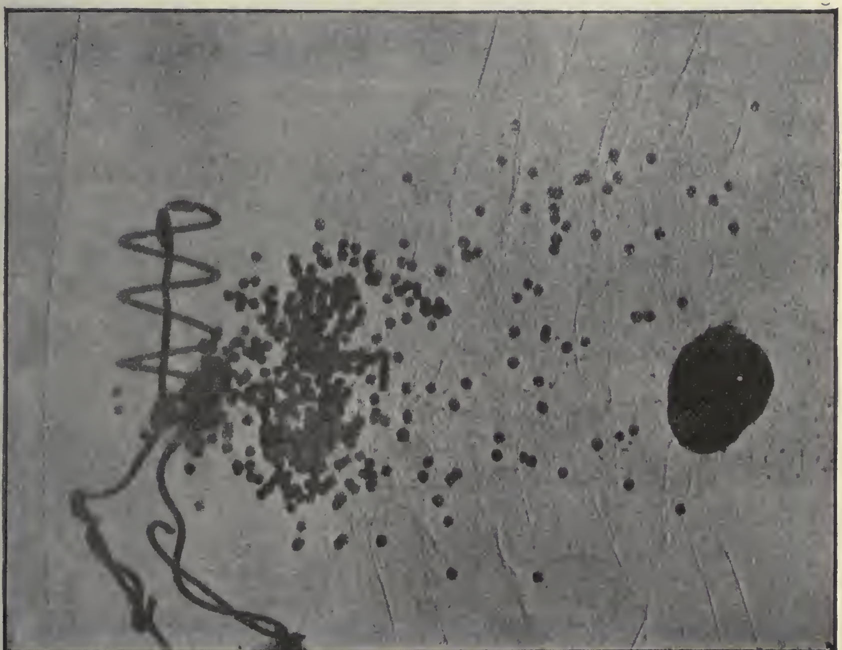


FIG. 13.

has been successful. One can of course test the action of any material mixed with the shot. For instance, in one case I mixed a few drops of liquid oil with the shot and found them more widely scattered in consequence, not, as has been stated, held together by the oil as if they were in a wire cartridge. Of course, solid grease or fat may, and no doubt does, produce such a result, but liquid oil certainly does not.

I was unfortunately not able, in the limited space and time that I have been able to employ, to take photographs of the shot at a reasonable distance from the gun, but I have taken comparative photographs at three or four yards only in which every shot is clearly defined, and in which it is even easy to see on the negative where the shot have been jammed into one another and dented. The difference in the scattering at this short distance is not sufficient for the results to give any information beyond this, that shot are as easily photographed as bullets, and that no difficulty need be apprehended in attempting to solve any question of the kind by this method. The photograph, Fig. 13, represents the shot from the cylindrical or right-hand barrel. The velocity now is so low that individual waves are no longer formed by each shot. The whole space, however, occupied by the

And now I wish to conclude with a series of photographs which show how completely the method is under control, how information of a kind that might seem to be outside the reach of experiment may be obtained from the electric spark photograph, and how phenomena of an unexpected nature are liable to appear when making any new experiment. The result, however, is otherwise of but little interest or importance.

I thought I should like to watch the process of the

piercing of a glass plate by a bullet from the first shock step by step, until the bullet had at last emerged from

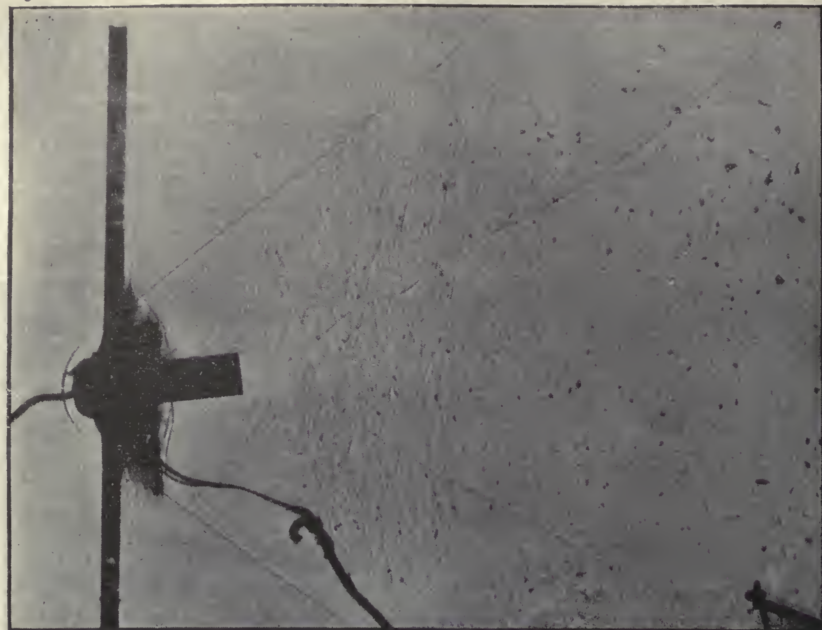


FIG. 14.

the confusion it had created. In Fig. 14 the glass plate is seen edgeways just after the bullet has struck it. It is clear at once that the splash of glass dust backwards is already four or five times as rapid as the motion of the bullet forwards. A new air wave is just beginning to be created in front of the glass-coated head of the bullet and two highly-inclined waves, one on either side of the glass, reaching about three-quarters of the way to the edge, have sprung into existence. These are more clearly seen in the next figure; meanwhile it may be well to point out that the fragments of paper which are following the bullets have in this case—as the card was much nearer to the glass plate than in those previously taken—some of them lost so much of their velocity and have in consequence lagged behind in a still higher proportion than the others, that they are travelling at less than 1100 feet a second; the more backward ones carry in consequence no air waves and there is no means of telling from the photograph that they are moving at all. In Fig. 15 the bullet has struggled about half way through the plate. The waves on either side of the plate have now reached the edge and are on their way back towards the centre again. They are caused in this way. When the bullet strikes the plate the violent shock produces a ripple or tremor in the glass which travels away radially in all directions, leaving the glass quiet behind. The rate at which this ripple travels may be found from the angle which these new air waves make with the plate, for taking any point on the plate and measuring up to the point where the air wave meets the plate and also the distance in air to the nearest point of the inclined air wave, we get two distances, the ratio of which is the ratio of the velocity of the disturbance in the glass to the velocity of sound in air. But much more than this is shown. An examination of the negatives or of a photographic print and even, but less clearly, of the print in the text shows that these inclined air waves are made up of a series of dark and light lines at a very slight

FIG. 15.

inclination to the air wave itself, so that as we travel

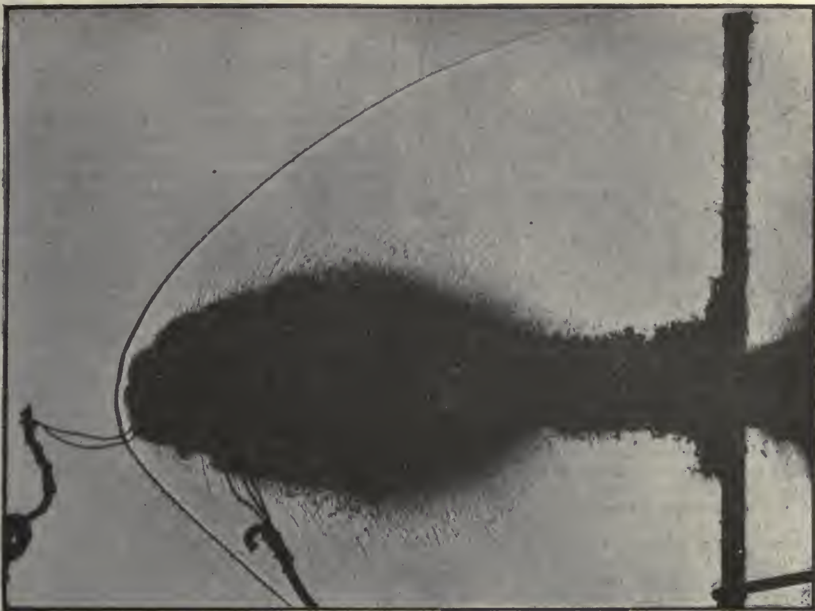


FIG. 16.

along the air wave it is alternately dark outside and light outside. These indicate the successive positions in which

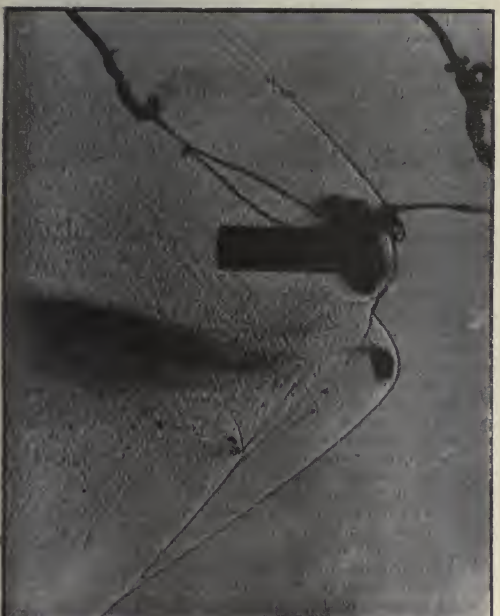


FIG. 17.

the glass first moved outwards to compress the air or first moved inwards to rarefy it so that the wave length of the ripple may thus be found, and finally it is seen that where the waves are waves of compression on one side of the plate they are waves to rarefaction on the other, indicating that it was a transverse and not a mere longitudinal disturbance that ran along the plate from the centre outwards and back again after reflection from the edge. In addition to this the fact that the reflected wave is still on its inward course proves that up to this time the plate is whole, as a wave cannot be propagated in a broken plate. Fig. 16 illustrates the state of affairs when the bullet has travelled about five inches beyond the plate. It has not yet emerged from the cloud of glass dust. The new head wave is very conspicuous. In the original negative, about half way between the bullet and the plate, the inclined waves due to the tremor in the glass plate may be detected, but they are too delicate to be reproduced by the printing process. They supply the information as to how long the plate remained whole or rather if the bullet had been caught a little sooner before these faint waves had lost so much of their distinctness they would supply this information with great exactness. Meanwhile the figure shows that the plate is now broken up completely. It is true it is still standing, and the stern air wave is seen reflected from the upper part of it, but this is because the different parts have not yet had time to get away; their grinding edges, however, have cast out from the surface little particles, and these are seen over the whole extent of the plate. After about fifteen inches the bullet is quite clear of the cloud of dust (Fig. 17); one piece only of the glass, no doubt the piece that was immediately struck, has been punched out and is travelling along above the bullet at a speed practically equal to its own. I am also able to show the plate itself in this and a still later stage, when at last the separate pieces have begun to be visibly moved out of their position and in some cases slightly turned round.

I have merely given this evening an account of a few experiments which in themselves perhaps are of little

interest, but they at any rate show the capability of this method for the examination of subjects which would in the ordinary way be considered beyond the reach of experiment. It is hardly necessary to say that the examples given by no means reach the limit of what may be done, I have examined the explosions produced by fifteen-grain fulminate of mercury detonators and of heaps of iodide of nitrogen, a material which is rather unmanageable, as if a fly even walks over it it violently explodes. In these cases the explosive flash was used to make the B gap of Fig. 4 conducting, for which it answered perfectly. One might in the same way examine the form of the outrush of powder gases past the bullet, and so find at once their velocity with respect to the velocity of the bullet, and I see no great difficulty in tracing, if this should be desired, the whole course of a single bullet for perhaps as much as 100 yards by means of photographs taken every few inches on its way. Though it may not be evident that these or similar experiments are of any practical importance, there can be no doubt that information may be readily obtained by the aid of the spark photograph, as in fact has been shown by Prof. Mach, Lord Rayleigh, Mr. F. J. Smith, and others, which without its aid can only be surmised, and that if, as in other subjects, the first wish of the experimentalist is to see what he is doing, then in these cases surely, where in general people would not think of attempting to look with their natural eyes, it may be worth while to take advantage of this electro-photographic eye.

I wish in conclusion to express my obligation to the gentlemen to whom I have already referred, to Messrs. Chapman and Colebrook for their assistance, and to Messrs. Moore and Grey for having supplied me with weapons and ammunition.

MICRO-ORGANISMS AND THEIR INVESTIGATION.[1]

As the field of bacteriological investigation becomes extended, we have of necessity constant additions to the various methods rendering possible the pursuit of researches in these novel directions. We have only to look at the first edition of Hueppe's "Methoden der Bakterien-Forschung," published in 1885, consisting of 174 pages, and compare it with the bulky volume of 488 pages which forms the fifth edition, to see at a glance the advance which has been made in the matter of methods alone. In Flügge's "Die Mikro-organismen" we have another type of book, dealing exclusively with micro-organisms themselves, and the information which has been gathered together concerning them, whilst all details of bacteriological practice are purposely omitted. Dr. Günther has attempted a welding together of these two types of book, special attention being given to microscopical technique with which his name is indeed more particularly associated.

The first part is devoted to a survey of our knowledge concerning bacteria in general, commencing with the earliest observations of Leeuwenhoek in 1683. In this review we find an account of their morphology, the principles upon which their classification is attempted, &c., together with a detailed account of the most recent methods for their cultivation and subsequent study, including careful directions for the use of the microscope, and a most elaborate description of the available means for staining bacteria.

The second part is confined to a consideration of the best-known pathogenic and non-pathogenic micro-organisms.

There could not be a more admirable account of the numerous manipulations involved in bacteriological investigations; all the minutiæ are described with the utmost care, and what is usually left for the student to learn in "profiting by his experience" is here carefully anticipated, and if he tumbles into any pitfalls, it is not because he has been without warning.

With such a big task as Dr. Günther has set himself it is not surprising to find some parts less amply dealt with than they would seem to deserve. Thus we find but a very meagre supply of culture media given, there is no mention of the preparation of milk, or of the special solutions employed by Pasteur, Naegeli, and others, neither is there any account of Kühne's silica jelly, which since our knowledge of the fact that certain organisms will only flourish in media devoid of all organic matter, ought surely to have been included.

On the other hand a minute description is given of gelatine-plate, dish and tube cultures, as well as of the most modern methods for the anaërobic cultivation of bacteria, &c. In connection with the abstraction of certain colonies from gelatine-plates, mention may be made of a piece of apparatus (the description of which was only published after Dr. Günther's book appeared) originally devised by Fodor, and called "Bakterien-Fischer," which has been, under the name of "Bakterienharpune," more recently modified and considerably cheapened by Unna. Every one has experienced the difficulty of fishing out a particular colony in a crowded plate, how it is almost impossible to look through the microscope and fix upon the centre to be abstracted, and at the same time keep the needle steady and ensure touching only the one colony which is required. By using the above contrivance, which can be attached to the microscope, the fishing out of such centres is greatly facilitated.

The examination of air for micro-organisms is only very slightly touched upon, as is also the bacteriological investigation of water. It is a little rash to assert that "pathogenic micro-organisms can live for a long time in sterilised water," considering that it has been shown in some cases that their *immersion* only is sufficient to destroy them. Again, no mention is made of Hansen's special methods for the examination of particular waters; although they are opposed to the Koch school, this ought not to preclude a reference to what has been proved by a large number of investigations to be, in some cases, of great practical utility.

The second part opens with a short introduction, in which the nature of pathogenic organisms in general is described, and an account given of the rigid proof which is required before a particular organism may be said to be the cause of a particular disease. Protective inoculation and immunity are briefly referred to, and Metschnikoff's brilliant theories of phagocytosis summarily dismissed, and declared incapable of standing the test of the "careful experimental criticism to which they have been submitted by Flügge, Baumgarten, and the author's own pupils."

As many as twenty-seven different varieties of micro-organisms are described in the section on the most important pathogenic bacteria. Amongst these we find the micro-organisms associated with anthrax, tuberculosis, diphtheria, cholera, pneumonia, tetanus, typhoid fever, and chicken-cholera, more especially dealt with, an exceedingly useful and comprehensive summary being given in each case of what is known concerning them, together with numerous references to original papers published on the subject. That Dr. Günther is an ardent disciple of Koch's will at once be admitted, when we read the terms in which he speaks of the *Tuberculinum Kochii*: "Eine neue Aera begann nicht allein für die Tuberculoselehre, sondern für die gesammte Medicin, mit der grossen Entdeckung Koch's der Heilung der Tuberculose."

[1] "Einführung in das Studium der Bakteriologie." By Dr. Carl Günther. Second Edition. (Leipzig: Georg Thieme.)
"Technique Bactériologique." By Dr. R. Wurtz. Encyclopédie Scientifique des Aide-Mémoire. (Paris: Gauthier-Villars et fils, 1892.)

Amongst the non-pathogenic forms we find an account of the *Micrococcus agilis*, which was found by Ali-Cohen in drinking water. This was not the first motile coccus found, as is stated by Günther, for previous to this, Mendoza isolated and described a motile form which he called *Micrococcus tetragenus mobilis ventriculi*. The *Micrococcus agilis* was the second variety found; whilst later, in 1890, Loeffler also discovered and described a motile coccus. It is surprising, therefore, to read that Ali-Cohen's variety is the only motile micrococcus known. The list has further been quite recently (1892) enriched by the discovery by Maurea of a motile sarcina, which he has designated *Sarcina mobilis*.

A fine set of seventy-six photographs, mostly taken from original preparations, together with a very exhaustive index, completes the volume. Amongst the photographic figures the series of twelve representing anthrax in every stage of development from the individual bacteria to their appearance as colonies on gelatine-plates, and growing in test-tube cultivations, are particularly beautiful; the surface colonies photographed after forty-eight hours' growth are especially characteristic and successful.

In the handy little volume "Technique Bactériologique," of Dr. Wurtz, chief of the laboratory for experimental pathology in the Faculty of Medicine in Paris, we have an entirely different stamp of book. We read in his preface: "On ne trouvera, dans ce précis de Technique bactériologique, ni l'historique, ni l'exposé detaillé des nombreuses méthodes techniques qui ont été préconisées jusqu'à ce jour en microbiologie. Conformément au programme tracé par la Direction de *l'Encyclopédie Scientifique des Aide-Mémoire*, nous nous sommes efforcés d'éxposer, aussi clairement que possible, les notions qu'un débutant doit posséder à fond avant d'aborder l'étude proprement dite des microbes."

Proceeding on these lines Dr. Wurtz gives us a very clear and precise account of all the various important stages passed through in bacteriological manipulations, commencing with a chapter on the principles of sterilisation.

But a novel feature in this volume is the description of the various methods of conducting experiments on animals for bacteriological purposes. This is carefully recorded and supplemented by woodcuts, and would appear to be a most useful addition, for although the possibilities of carrying out such experiments in this country are very limited, yet in those cases where they are permitted such an accurate description of the methods to be adopted should prove very helpful, more especially as in very few of the German and English bacteriological text-books is any account to be found for the information of those desiring to undertake such investigations. A chapter is also devoted to the enumeration of the substances, in as far as they have been investigated, which are elaborated by micro-organisms and a description of the most convenient methods for their successful extraction.

The crisp and concise language which characterises the book, together with the judgment displayed in its compilation, show that the author possesses, not only a full grasp of his subject, but is also highly skilled in the art of communicating it to others.

GRACE C. FRANKLAND.

THE ORDNANCE SURVEY.

A DEPARTMENTAL committee was appointed by the Board of Agriculture in April, 1892, to inquire into the condition of the Ordnance Survey. The committee consisted of Sir John E. Dorington, M.P. (chairman), Sir Archibald Geikie, F.R.S., Mr. Henry W. Primrose, Mr. William Mather, M.P., Mr. H. J. Roby, M.P., and Mr. Charles Fortescue Brickdale, with Major Duncan A. Johnston, R.E., as secretary. The matters referred to then were:—

1. What steps should be taken to expedite the completion and publication of the new or revised one-inch map (with or without hill-shading) of the British Isles?

2. What permanent arrangements should be made for the continuous revision and speedy publication of the maps—1 in 500 (towns), 25 in., 6 in., and 1 in. scales?

3. Whether the maps as at present issued satisfy the reasonable requirements of the public in regard to the style of execution, form, information conveyed, and price, and whether any improvement can be made in the catalogue and indexes?

After the appointment of the committee Mr. T. Ellis, M.P., asked in the House of Commons a question which showed that there was dissatisfaction with regard to the inaccuracy and incompleteness of the names of places in the map of Wales; and this question was also referred to the committee.

The report of the committee has just been issued, and includes the following recommendations:—

1. That the 1 in. map be produced in the following forms:—

(*a*) An engraved outline map, with contours in black.

(*b*) A black engraved map, with hill-shading either in black or in colour.

(*c*) A coloured map on thin paper, adapted to military purposes, but also on sale to the public.

(*d*) A cheap map by transfer to zinc or stone.

2. That the character of the roads on the 1 in. map be shown in four classes with distinct characteristics.

3. That parish boundaries be omitted from the 1 in. map.

4. That the contours of the sea bottom round the coast line and the depths of inland waters be shown.

5. That experiments be made in the practical application of heliogravure, and that, if results not inferior to an Austrian specimen map which we have seen be produced, that process be substituted for the existing method of engraving hills, and for so much of the country as is then uncompleted in its hill engraving.

6. That special arrangements be made to revise the 1 in. map within the next four years independently of the maps on the larger scales, and that subsequently this map be constantly revised within periods of fifteen years.

7. That the cadastral maps be revised and brought up to date in the next ten years, and that subsequently they be kept revised within periods of fifteen years.

8. That the publication of these revised maps be carried out by contract, if necessary.

9. That detail, such as single trees, footpaths in gardens, &c., be omitted.

10. That the skeleton and coloured forms of the 25 in. and town maps be abandoned, and the uses of both be combined in one edition having the houses cross-hatched.

11. That the reference numbers to parcels of land on the 25·344 in. plans be abandoned on revision.

12. That to a limited extent additional contour lines be added to the 6 in. map.

13. That on the 6 in. map the contours be always in black.

14. That certain of the engraved plates of the 6 in. map which are not now filled up beyond the county boundary be as soon as possible filled up to the margin of the plate with the detail of the adjoining county.

15. That the cost of the engraved sheets of the 6 in. map and that of the quarter-sheets of the photo-zincographed 6 in. map be equalised by a change of their respective selling prices.

16. That the Welsh names be gone over and corrected before the first revision of that map.

17. That the cadastral maps on the town scales be no longer entirely made or revised at the cost of the State, but that the town authorities be required by statute to maintain these maps.

18. That around towns and in tourist districts the existing sheets of the Ordnance Survey on the 6 in. and 1 in. scales be united so as to form special maps of such districts, and that advantage be taken of these maps to introduce any novelties in cartography that may be thought desirable, as these maps are not required to be joined to the general maps of the United Kingdom.

19. That certain authorities be placed under statutable

obligation to supply information to the Ordnance Survey Department in order to enable current revision to be better carried on.

20. That in future the term "revision" should be confined to the bringing up to date on its existing scale of a map already published, and that the term "resurvey" be applied to the operations necessary for the production of maps on a scale larger than that on which they were originally published.

21. That the Ordnance Survey Department be allowed to control its own supply of paper and printing material.

22. That the map on the scale of four miles to an inch be revised as soon as the 1 in. map is out of hand, and be completed with hill-shading.

23. That great freedom be allowed to private publishers desirous of bringing out other classes of maps than those specially published by the Survey Department, and that transfers of the maps on the 1 in. and smaller scales be supplied to publishers at cost price, a small sum being paid as an acknowledgment, and that all other reproduction of Ordnance Survey maps be prohibited.

24. That certain recommendations as to indices and catalogue be carried out.

25. That a book or pamphlet of information as to the Ordnance Survey be published, general in its main features and special for each county, containing the county indices or diagrams (on a reduced scale) and the information formerly contained in the parish area books, and also the table of parish areas now printed on the index of the 6 in. map, which table should in future be omitted from that map, and that copies of the small indices in this pamphlet be freely distributed for public information.

NOTES.

Owing to the large demand for tickets for the Croonian Lecture, which is to be delivered by Prof. Virchow before the Royal Society and their friends next Thursday, it has been decided to hold the meeting in the theatre of the London University, which has been lent for the occasion by the kind permission of the Senate.

The public dinner which is to be given in honour of Prof. Virchow will be held on March 16, after the delivery of the Croonian lecture, at the Hôtel Métropole. Lord Kelvin will preside, and will be supported by the Presidents of the Royal Colleges of Physicians and Surgeons as vice-chairmen.

At the Nottingham meeting of the British Association, over which Prof. Burdon Sanderson will preside, Lord Salisbury will be nominated president of the Association for the Oxford meeting in 1894. The following gentlemen have consented to act as presidents of sections at Nottingham :—Section A, Mathematical and Physical Science, Prof. Clifton, F.R.S. ; Section B, Chemistry and Mineralogy, Prof. J. Emerson Reynolds, F.R.S. ; Section C, Geology, Mr. J. J. H. Teall, F.R.S. ; Section D, Biology, the Rev. Canon Tristram, F.R.S. ; Section E, Geography, Mr. Henry Seebohm, Sec. R.G.S. ; Section F, Economic Science and Statistics, Prof. J. S. Nicholson ; Section G, Mechanical Science, Mr. Jeremiah Head ; and Section H, Anthropology, Dr. Robert Munro.

At the ordinary meeting of the Royal Meteorological Society, to be held at 25, Great George Street, Westminster, on Wednesday, the 15th instant, at 7 p.m., a lecture will be given by Mr. Shelford Bidwell, F.R.S., on some meteorological problems, which will be illustrated by experiments.

Dr. R. Thorne Thorne, Medical Officer of the Local Government Board, and Mr. H. Farnall, of the Foreign Office, have gone to Dresden, the former as British delegate to the International Sanitary Conference in that city, the latter as assistant delegate.

The students of the Royal College of Science propose to hold a conversazione in the South Kensington Museum on the evening of March 23 next. In the course of the evening Mr. Boys, F.R.S., will deliver a lecture on soap bubbles, illustrated by his own interesting experiments. The evening will be further enlivened by various public singers, and a selection of music will be played by the band of the Grenadier Guards.

In reply to a question put by Sir Henry Roscoe in the House of Commons on Friday last with regard to the proposed new buildings for the Royal College of Science, Mr. Shaw Lefevre said :—" The accommodation at the Royal College of Science is now undoubtedly inadequate, and in my opinion new buildings must be undertaken at some early opportunity. Block plans were drawn up in 1891 by the professors of the Royal College of Science, showing a suggested appropriation of the land on the south side of the Imperial Institute Road, for the purposes both of the Royal College of Science and of the Science Museum, and these plans were submitted to the Office of Works ; but that Department pointed out that it would be premature for them to consider the plans until the Science and Art Department had obtained the sanction of the Treasury to an organisation of their teaching and exhibition establishments on the scale contemplated in the plans. I understand that the Science and Art Department are now in communication with the Treasury in this sense." Sir H. Roscoe having asked when the report from the Science and Art Department would be issued, Mr. Shaw Lefevre said it was not in the nature of a report that could be issued to Parliament, but he should be happy to show it to the hon. member.

Last week a meeting, convened by the Duke of Westminster as president of the Royal Agricultural Society, was held at 12, Hanover Square, to consider the best means of commemorating the completion of the first half-century of the agricultural experiments which have been continuously carried on by Sir John Lawes at Rothamsted since the year 1843. The Prince of Wales presided. On taking the chair his Royal Highness stated the objects of the meeting. The Rothamsted experiments had from the commencement been entirely disconnected with any external organisation and had been maintained at the sole cost of Sir John Lawes. For the continuance of the investigations after his death Sir John had recently made the munificent endowment of £100,000, besides the famous laboratory and certain areas of land, and had nominated some of the most distinguished men of science of the day to administer the trust. In view of all these facts, and the great national importance of the Rothamsted experiments, it was only fitting that some public recognition should be made of the invaluable services rendered to agriculture by Sir John Lawes and his distinguished colleague, Dr. Gilbert. The Duke of Westminster said they all hoped that Sir John might live for many years to continue to carry on these experiments for the benefit of agriculture. He had great pleasure in proposing the following resolution :—" That, having regard to the great national importance of the series of experiments which have been carried on at Rothamsted during the last fifty years, it is desirable that some public recognition should be made of the invaluable services thus rendered to agriculture by Sir John Lawes, and also by Dr. Gilbert, who has been associated with the experiments during the whole period. That, with this object, subscriptions, to be limited to two guineas, be invited from all interested in agriculture, whether scientific or practical." Mr. Thiselton-Dyer, F.R.S., seconded the resolution—not as an agriculturist, but as one officially and all his life deeply interested in everything that was concerned with botanical science. The extraordinary merit of the work carried on at Rothamsted lay in the fact that those experiments had been continuously carried on under uniform conditions for so long a

period. He ventured to say, as a scientific man, that he knew nothing in the whole records of scientific research more honourable to this country than those experiments which were being carried on at Rothamsted with such self-denying skill. The resolution was then put by the chairman, and carried unanimously. Sir John Evans moved :—"That, in the opinion of this meeting, the testimonial might advantageously take the form of —(1) a granite memorial, with a suitable inscription, to be erected at the head of the field where the experiments have taken place; (2) addresses to Sir John Lawes and Dr. Gilbert, accompanied (if funds permit) by a commemorative piece of plate." This was also carried, and it was unanimously resolved that the following should be requested to act as a committee for carrying the resolutions into effect :—The presidents of the Royal, Royal Agricultural, Linnean, and Chemical Societies, the Earl of Clarendon, Viscount Emlyn, Sir John Lubbock, Sir John Evans (hon. treasurer), and Mr. Ernest Clarke (hon. secretary), with power to add to their number. The Duke of Westminster moved a vote of thanks to the chairman, and the Prince of Wales said, in response, that nothing had given him greater pleasure and satisfaction than to take the chair on that occasion, and to testify, as an agriculturist, his own sense of gratitude for what Sir John Lawes had done for agriculture. Subscriptions to the fund may be sent to any member of the committee, to Sir John Evans, F.R.S., at Nash Mills, Hemel Hempstead, or to Mr. Ernest Clarke, at 12, Hanover Square, W.

LORD SALISBURY presided over a meeting held at Oxford last week, in aid of the building fund of the Radcliffe Infirmary. He delivered a most vigorous address, in the course of which he said that at Oxford the difficulty connected with medical education was the reverse of that felt in London. In London the practical opportunities of exercising medicine were abundant, and the only care, or the main care, which pressed upon those who had charge of education in that respect was lest the more scientific basis of that practice should be neglected or receive inadequate attention. At Oxford, on the contrary, they had abundant means of teaching the group of sciences which were the equipment of the physician. But, necessarily, unless they made a great effort to that end, they should not have the means of presenting those opportunities of practical inquiry which were essential to the formation of the professional ideal, and which in large populations necessarily occurred with so much greater frequency. This movement—for so he looked upon it—on the part of the rulers of the University, to draw somewhat closer to the science of medicine, was only part of a larger movement which had been going on for some time, which, if he might use the scientific language of the day, was part of the evolution of education in our time. He begged to assure the assembly that he had no traitorous views with respect to the study of Greek. In fact he was inclined to say that in recent controversies the advocates of the classical languages had been unduly frightened, and that there was not the slightest danger that the study of them would ever pass from the education of youth or the culture of men of intellect. The issue was not between science and languages, ancient or modern; the issue rather was between the science whose chief food was gathered from observation and the science whose chief food was gathered from reflection. This older science was slowly, very slowly, but still quite evidently, giving way to the sciences which relied upon observation. He always thought that the science of medicine had scarcely received among us all the tribute which it ought to receive among sciences which rest upon observation. It was a curious fact that the whole tendency of scientific thought appeared to be rapidly concentrating itself upon the fields in which medicine reigned supreme. Those infinitely minute beings which certainly for health or sickness deeply affected our existence, and which were so essential to us that some able scientific men said that we consisted of nothing else, that we were not only a Republic, but were in a permanent state of civil war—these bacilli were attracting more and more the attention of the scientific intellect in Europe. It was dangerous to prophesy, but he did not think that any one who had watched the course of science would doubt that for the generation to come the investigation of these creatures, which had been revealed by new methods of research and by singularly patient labour, and upon which the lives of millions of human beings depended, would figure more largely in the scientific field than any other study. This was the special domain and privilege of medicine. He felt, therefore, that in commending this appeal to their consideration he was doing more than preaching a charity sermon. He was asking them to help that which contained the most brilliant promise for the intellectnal future of science in a University by which science ought to be cultivated and where science ought to reign.

AFTER Lord Salisbury's address various resolutions were adopted, among which was one, moved by Prof. Dicey, to the effect that the Radcliffe Infirmary, being the chief hospital for Oxford and a large surrounding district, should be brought into a state of efficiency corresponding with the recent advances in hospital management. Another resolution, moved by the Master of University, expressed approval of the committee's scheme, consisting of the removal of the sick from the old building into more modern wards and the renovation of the old building.

ON Saturday and Sunday last much damage was done in Sandgate, near Folkestone, by remarkable disturbances of land. The first disturbance was felt on Saturday at 7.45 P.M., when a rocking motion was noticed. This soon stopped, but later disturbances were so alarming that many people took their furniture into the streets. According to a correspondent of the *Times*, houses "slipped away from each other, leaving gaping sections," while in other cases the walls bulged out, and great rifts appeared in the ground. In the area affected by the disturbances most, if not all, of the houses are out of line and show cracking. Many of the inhabitants have been brought to great distress by the calamity, and appeals to the public have been issued on their behalf. An inquiry into the cause of the disaster was held at Sandgate on Tuesday by Mr. Walton, Local Government Board Inspector. After hearing evidence the Inspector said that an official report would be sent to the Board. What he had seen led him to conclude that the catastrophe was due to the sudden release of impounded subsoil water, a thing which he believed was remediable by the institution of proper water drains. If that was attended to there was no reason to suppose that such a disaster would ever recur. The *strata* were full of water, which the recent abnormal rainfall had served to increase. That water being released had formed kinds of caverns. The remedies were proper storm drains and intercepting drains, with free outlets under the road to the sea.

THE death of Ludwig Lindenschmit, the well-known German archæologist, is announced. He died at Mainz on February 14 in his eighty-fourth year. He was the director and one of the founders of the fine Central Romano-German Museum at Mainz, and one of the editors of the "Archiv für Anthropologie." Among his works are "Die vaterländischen Altertümer der fürstlichen Hohenzollernschen Sammlungen" and his "Altertümer unserer heidnischen Vorzeit." He began a "Handbuch der deutschen Altertumskunde," but completed only the volume relating to the Merovingian period. Lindenschmit was an enthusiastic advocate of the theory that the Aryan race is of European origin.

THE temperature during the past week has been generally very high for the season, the daily maxima frequently exceeding

55°, and even reaching 59° in the eastern counties on Sunday; whereas the average maxima for the month, deduced from twenty years' observations at the telegraphic reporting stations of the Meteorological Office, range from about 45° in the north to 50° in the south and south-east. During the latter part of last week several depressions skirted our north-west coasts, and rain fell generally every day, although the amounts measured were not great; but on Sunday the type of weather changed, especially over the southern part of the kingdom. An anti-cyclone advanced over our south-west coasts from the Atlantic, while the air became dryer and conditions more settled, although there was little sunshine in any part of the kingdom. There was a deep depression over Norway on Tuesday, while secondary depressions in connection with it were approaching the north-west of Scotland, and occasioning a return of stormy weather in the northern parts of these islands. From the *Weekly Weather Report* it appears that for the week ending the 4th instant the rainfall was above the average in all districts except the north of Scotland and the south of Ireland. Over the northern parts of England and the east of Scotland the excess was large, owing chiefly to heavy snowfall at the beginning of the period.

AMONG the various marine zoological stations which, on the initiative of that at Naples, have sprung up in recent years, the station at Trieste, on the Adriatic, holds an honourable place. It has been in existence nearly eighteen years. Dr. Claus states (*Naturw. Rdsch.*) that for its double function of instruction and investigation opportunity is afforded both to students and men of science. The students are, primarily, those of the professors of zoology at Vienna University, to whom the management is entrusted; also those of the Graz professor, who has a right to four places out of twelve. Students of other Austrian Universities are also freely admitted to work, and Austrian and foreign investigators. To each worker the ordinary reagents, besides the table, are supplied gratis; also the material, so far as it can be provided without special cost. The station further supplies living and preserved marine animals as specimens to the Zoological Institutes of the Vienna and Graz Universities, sending thither about 120 to 140 specimens annually. Other institutes are supplied on payment as arranged. The number of workers at the station has gone on increasing since it was opened in 1875. Of foreign investigators who have used it may be named Metschnikoff, Kowalevsky, A. Schneider, Selenka, R. and O. Hertwig, Keller, E. van Beneden, Fromann, Braun, and F. Cohn. The results of work carried on there are sometimes published independently, but they chiefly appear in the *Arbeiten* of the Zoological Institute of Vienna University, and the Zoological Station in Trieste, of which ten volumes have appeared. The *Denkschriften* and *Sitzungsberichte* of the Vienna Academy and the German zoological journals also witness to the activity of the station. The Austrian Government has liberally aided this useful institution.

THE new number of the Journal of the Institution of Electrical Engineers contains a report of some very interesting speeches on a paper by Dr. Fleming on experimental researches on alternate-current transformers. The same number includes Mr. Preece's presidential address, from which we have given some extracts. The vote of thanks to the president for his address was proposed by Mr. Spagnolletti and seconded by Sir Henry Mance. Sir Henry said there was one point in the address which had struck him with dismay. That was the gradual increase of the teredo in the neighbourhood of our shores. This fact had been brought home to him that day by specimens of cable recently attacked by "the insect, or mollusc"; and it should teach them—what Mr. Preece had told them many years before—that they should not only survey the bottom of the sea for rocks and shoals, but should also examine it near the shores to find whether it was infested by that pest, which had damaged hundreds of thousands of pounds worth of cable.

THE results of the solar, meteorological, and magnetical observations made during 1892 at the Stonyhurst College Observatory have just been issued by Father Sidgreaves. They take the commendable form of monthly and annual summaries, so that the most interesting results can be seen at a glance, and compared with the mean results of the last forty-five years. The range of barometer readings was only 1·724, or a quarter of an inch lower than the mean, while the range of the thermometer was seven degrees higher than the mean. The extreme range of the barometer recorded at this observatory is 3·13 inches. Sunshine was recorded for 207 hours in June, 202·1 in April, and only 172 in May. From January to April there is a regular increase, and from June to December a regular decrease, the falling-off in May being very conspicuous. 153 drawings of the sun have been added to the already splendid Stonyhurst series. An appendix contains the results of meteorological observations made at St. Ignatius College, Malta.

WE learn from the *Botanical Gazette* that there are now as many as thirty-two botanical stations in the United States carried on by the various State Governments. The subject which receives most attention at these stations is that of the fungus and bacterial diseases of cultivated crops and of fruit-trees, and their treatment and cure. Some of them give attention to systematic botany, while others are investigating the life-history of certain fungi, or carrying on physiological work. A laboratory for the study of plant diseases has recently been fitted up in connection with the agricultural experiment station of the University of California at Berkeley. It has been arranged that a botanical survey of Nebraska shall be undertaken by the Botanical Seminar of the University of that State. The almost unknown flora of the north central portions of Idaho has recently been investigated, as we have already noted, by a commission acting under the auspices of the Botanical Division of the U.S. Department of Agriculture.

IN the first part of Dr. Millspaugh's Preliminary Catalogue of the Flora of Western Virginia, published in the Bulletin of the Agricultural Experimental Station of Morgantown, a new feature has been introduced in a list of the rich fossil flora of the State.

PROF. ANGELO HEILPRIN, of the Peary Relief Expedition, has presented to the Museum of the Academy of Natural Sciences, Philadelphia, the valuable collection of mollusks dredged by him in Greenland waters. They have not yet been studied, but the conservator of the conchological section, in his annual report, says he has ascertained the presence of a number of species not before in the collection of the Academy, of the genera *Margarita*, *Buccinum*, *Sipho*, and other Arctic groups. The specimens preserved in alcohol are in excellent condition for the examination of the soft parts.

MR. J. W. SALTER, writing to the *Zoologist* from University College, Aberystwith, says that on January 4 last he obtained a polecat about six miles south of Aberystwith. There is reason to believe, he says, that the species is by no means extinct in Cardiganshire.

THE Pharmaceutical Society of Great Britain has issued a volume of papers, most of which describe the results of chemical investigations carried on at its Research Laboratory. The editor is Prof. W. R. Dunstan. The papers are reprinted from the Transactions of the societies to which they were communicated, namely, the Royal Society, the Chemical Society, the Pharmaceutical Society, and the Physical Society. Other volumes of a like kind are to follow.

THE new number of the Journal of the Royal Horticultural Society includes, besides papers on many other subjects, reports of conferences on the begonia and on apricots and plums. There is also a long series of extracts from the Proceedings of the society.

THE second part of the excellent "Canadian Guide Book," by Ernest Ingersoll, has been issued (W. Heinemann). It deals with western Canada, and the author has been at great pains not only to collect full and trustworthy information, but to present it in a clear and attractive style. There are maps and many illustrations.

THE results of an investigation concerning the nature and properties of metallic ruthenium, particularly with respect to the fusing point of this highly refractory rare metal, are contributed by M. Joly to the current number of the *Comptes Rendus*. M. Joly has accumulated no less than three kilograms of pure metallic ruthenium, and has consequently been enabled to carry out experiments upon it on a comparatively large scale. It will doubtless be remembered that ruthenium and osmium are the two most refractory of the metals of the platinum group. Deville and Debray only succeeded with great difficulty in obtaining a few minute globules of melted ruthenium with the aid of the oxyhydrogen blowpipe. The fusion of this metal is rendered very much more difficult owing to the readiness with which, at these high temperatures, it becomes converted into the volatile tetroxide RuO_4. It was apparent therefore that in order to attain success the temperature must be suddenly raised to a point considerably higher than the melting point of the metal; and in order to effect this a much more powerful source of heat than the oxyhydrogen blowpipe would be required. M. Joly has therefore employed the electric arc, which has recently been shown by M. Moissan to be so admirably adapted for the preparation of refractory metals. At the high temperature of a powerful arc ruthenium is melted in a few seconds, and without sensible loss by volatilisation in the form of tetroxide. Solid ingots of twenty to thirty grams of the metal have been obtained in this manner without difficulty. As the melted metal cools, however, it becomes covered with a coating of the blue sesquioxide Ru_2O_3 and the dioxide RuO_2. In order to remove this the ingot is placed first in aqua regia, which, however, has no action upon either the metal or the oxides, and subsequently in hydrofluoric acid; finally the ingot is heated in a stream of hydrogen, when it loses the last traces of oxide and the pure metal remains. Pure ruthenium thus obtained in tolerably large quantities after fusion is a greyish-white metal, more nearly resembling iron than platinum in appearance. Its hardness is about the same as that of iridium. It possesses a crystalline structure and is brittle. The density of the metal after fusion M. Joly gives as 12·063 at 0° compared with water at 4°. Employing the same electric arc and under equal conditions in all respects, the fusion of ruthenium appears to be attended with appreciably greater difficulty than that of rhodium and iridium, whose melting points are somewhat higher than the melting point of platinum. Moreover, under the conditions which suffice for the ready fusion of ruthenium, osmium merely sinters, traces of fusion being just apparent. Osmium therefore is the most infusible of the metals of the platinum group. M. Joly is now conducting experiments with the view of determinining the actual temperatures of these interesting high melting points.

NOTES from the Marine Biological Station, Plymouth:—The week's captures include the Lucernarian *Depastrum cyathiforme* and numbers of the Gephyrean *Petalostoma minutum*, Kef. Ephyræ of *Aurelia* have been abundant; Hydroid medusæ scarcer. Polychæte larvæ and *Nauplii* continue plentiful, and *Cyphonautes* (larva of the Polyzoan *Membranipora pilosa*) has considerably increased in numbers. Echinoderm larvæ (*Auricularia*, *Pluteus*) have made their first appearance in the season's townettings. The Nemertine *Nemertes Neesii* and a large eyeless mud-dwelling species of the Polychæte genus *Polydora* (*flava*, Clap. ?) are now breeding.

THE additions to the Zoological Society's Gardens during the past week include a Black-faced Spider Monkey (*Ateles ater*) from Eastern Peru, presented by Miss Gertrude Farmer; a Macaque Monkey (*Macacus cynomolgus*, ♂) from Java, presented by Mrs. Frank Phillips; a Naked-footed Owlet (*Athene noctua*) European, presented by Mr. Albert Stevens; a Four-horned Antelope (*Tetraceros quadricornis*, ♂) from India, purchased; six Wild Swine (*Sus cristatus*), two Badgers (*Meles taxus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET BROOKS (NOVEMBER 19, 1892).—The following is a continuation of last week's ephemeris for this comet:—

12h. Berlin Mean Time.

1893.	R.A. (app.) h. m. s.	Decl. (app.) ° ′	Log r.	Log Δ	Br.
Mar. 9 ...	0 46 27 ...	+20 46·1 ...	0·1842 ...	0·3563 ..	0·47
10 ...	47 22 ...	34·4			
11 ...	48 17 ..	23·0			
12 ...	49 11 ...	12·1			
13 ..	50 4 ...	20 1·5 ...	0·1946 ...	0·3731 ...	0·42
14 ...	50 57 ...	19 51·5			
15 ...	51 49 ...	19 41·0			
16 ...	0 52 41 ..	19 31·2			

This comet will soon be lost in the rays of the sun. The unit of brightness took place on November 21·5, 1892.

COMET HOLMES (1892, III.).—M. Schulhof gives the following ephemeris of this comet for the ensuing week:—

1893.	R.A. (app.) h. m. s.		Decl. (app.) ° ′ ″
March 9 ...	2 43 7·1	...	35 8 11
10 ...	44 52·2	...	10 58
11 ...	46 37·2	...	13 46
12 ...	48 23·4	...	16 35
13 ...	50 9·4	...	19 24
14 ...	51 55·7	...	22 14
15 ...	53 42·2	...	25 3
16 ...	2 55 29·0	...	27 53

UNIVERSAL TIME.—On February 6 last the Bill declaring the legal time for Germany to be that of the 15th meridian east of Greenwich, that is, one hour in advance of Greenwich time, passed the third reading. This law will be brought into force on April 1. The *Observatory* for March informs us that, in a letter addressed to the Astronomer Royal, it is stated by Dr. Schran that a similar Bill has been laid before the Austrian Government, and "it is hoped that the change will be made simultaneously with Germany." The draft of the latter Bill, which we take from the same number, provides:—

(1) That the legal time in Austria is the mean solar time of the meridian 15° east of Greenwich. The same to replace, on April 1, 1893, the present local times for legal, civil, and all other purposes.

(2) The Government is authorised to make the changes in the school and industrial hours which will become necessary in consequence of the adoption of the above.

THE BIELIDS, 1892.—M. Bredichin, in *Astronomischen Nachrichten*, 3154, has a short note on the Bielids, in which he says that the observations made in America on November 23 last show that the meeting of the densest part of this swarm with the earth has taken place almost four days earlier than in the year 1885, or, in other words, that the descending node of the stream has receded almost 4° to the west during the period between the end of 1885 and the end of 1892. The cause of this recession is, he says, due to Jupiter, the perturbations set up by this planet accounting for the mean daily motion which is nearly equal to that possessed by Biela's comet.

An approximate computation of the special perturbations for the whole period during which Jupiter had any influence gave

for the recession of the node a little over 4°, the inclination decreasing about 0°·6.

THE WOLSINGHAM OBSERVATORY.—In the Report of this observatory for the year 1892 Mr. T. E. Espin tells us that although the zone work was interrupted by attention being given to Nova Aurigæ, yet one hundred and sixteen new Third-Type Stars were detected in zones + 55° and 56°. In the autumn, as the telescope was going to be devoted to the revision of double stars in connection with the new edition of "Celestial Objects for the Common Telescope," the driving clock was taken out and cleaned, and a new arrangement for letting the clock run for one and a half hours without rewinding was also added. Notwithstanding the pressure of work in this direction, as many as eight hundred and forty-seven measures were made in the autumn, "observing being carried on sometimes for twelve hours, and once for thirteen and a half at a stretch." With respect to the new edition of the work mentioned above, Mr. Espin gives a short description of the general scheme. The portions devoted to the planets and the sun (vol. i.) will have several foot-notes added to them, Mr. Denning will write a short chapter on comets and meteors, and chapters on celestial photography and spectroscopic work will also be inserted. The second volume will deal with double stars, &c., and will be entirely rewritten; the objects will be arranged in order of Right Ascension, and all double stars whose primaries are above 6·5 magnitude, and whose distance is less than 20″, will be included. The work of bringing the places up to 1900 was at the end of the year completed for the first twelve hours, and considerable progress has already been made in the next eight hours of Right Ascension. Mr. Espin refers to the death of Miss Compton, who took great interest in the work done at the Observatory, and who left a legacy for the purchase of a photographic telescope. This telescope is already in working order, its aperture being eight clear inches, and focal length forty-two inches, and will be devoted to the photography of the zones observed with the spectroscope for detecting variation in light. The Meteorological Department has also been increased by a hygroscope and solar radiation thermometer, the gifts of Miss Brooke.

UNITED STATES NAVAL OBSERVATORY.—From the report of the superintendent (Capt. F. C. McNair) of this observatory for the year ending June 30, 1892, we gather the following few notes. In October, 1891, owing to the retirement of Prof. Asaph Hall, the use of the 26-inch refractor was tendered to Mr. Asaph Hall, junior, the latter observing the satellite of Neptune, satellites of Saturn, and the two outer satellites of Uranus. During the period of opposition of Mars, in August, 1892, the instrument was employed by Prof. Hall for the purpose of securing measures of the satellites, as the superintendent thought that "it seemed fitting that Prof. Hall, the discoverer of these satellites, should have the privilege of observing them once more under such exceptionally favourable circumstances." With the transit circle practically no observations were made, as the instrument was under repairs previous to being set up in the new observing houses; the Meridian transit, on the other hand, was in constant use, chiefly in connection with the time service. The 9·6 inch equatorial was as usual employed in observing asteroids, occultations, &c., while two nights a week were set apart for the accommodation of visitors. The number of visitors at night is about 2500 per annum, the majority of whom are women. In the estimates of appropriations required for the service for the year ending June 30, 1894, we see that the superintendent asks for an expert elevator conductor, which is essential to prevent accident. Among the estimates for the new observatory is a request for three dwellings for observers, and this is accompanied by a note which we print here, and the truth of which every astronomer will endorse:—"In order that the work of a large observatory may be properly and economically done, it is absolutely necessary that the observers be within prompt call to their instruments throughout day and night. Very important observations can often be secured from the clearing of the sky for a few hours, or even in some cases for a few minutes, if the observer be within easy call by the watchman. This can only be accomplished, in the isolated situation of the new Observatory, by having dwellings upon the grounds for the observers. The Government erects dwellings at all its navy-yards, arsenals, forts, and schools for the officers on duty there. But no service requires such unremitting attention and constant presence at all hours as that of the astronomer, and no observatory can be regarded as economically managed which does not furnish dwellings for all its observers close by their instruments. It is estimated that with the observers living on the grounds of the new Observatory, not only will two or three times as much work be done as it will be possible to do otherwise, but the quality of this delicate work will be materially improved on account of the observers being in a proper physical condition to begin their labours, instead of with nerves unstrung from hurrying some miles from their homes immediately after meals, or at unreasonable hours of the night."

YALE ASTRONOMICAL OBSERVATORY.—Vol. i. Parts 3 and 4 of the publications of the Astronomical Observatory of Yale University contains (1) "A Triangulation of Stars in the Vicinity of the North Pole," by Prof. William L. Elkin; and (2) "Determination of the Orbit of the Comet 1847 VI.," by Miss Margaretta Palmer. With regard to the former paper, this was undertaken to determine the relative positions of some north polar stars to serve as fundamental points for a photographic survey of that region. Twenty-four stars, covering a considerable area, were selected for this work, and all the distances measured were large—that is, above 1000″. Out of 276 possible combinations of measuring the intermutual distances within the range of the heliometer, Prof. Elkin managed to employ 146, each combination undergoing three separate measurements. In the reduction of the measurements he gives full information as to the methods employed, showing the means of eliminating the systematic errors, &c., concluding with tables of the final results in Right Ascension and Declination and precessional tables. Miss Palmer prefaces her determination of the orbit of comet 1847 VI. with a short reference to its discovery and history, remarking that it is probably the only comet ever discovered independently by two women. Rümker in 1857 found the orbit to be of a distinctly hyperbolic nature, and the result of the present determination, by employing modern places for the sun and allowing for perturbations, &c., show that the observations can be best explained on the hypothesis of the hyperolic orbit, the new value for the elements differing slightly from the old ones.

GEOGRAPHICAL NOTES.

A COLONY only accessible through foreign territory is naturally unsatisfactory to its holders, and since the development of German South-west Africa, the inconvenience of having Walfish Bay as the only landing place for the interior has gradually increased. It is now announced that a new harbour has been found on German territory in the mouth of the Swartkop river. The stream is so small that it is marked on few general maps of Africa, and it may even turn out to be in the British sphere.

A PAPER for the next German Geographentag has been published in advance, by Prof. W. Köppen, under the title "Die Schreibung geographischer Namen." It deals in a very thorough manner with the principles which ought to regulate the orthography of place-names, and treats the whole matter of authoritatively published rules in a historical way from the first formulation of the Royal Geographical Society's Rules in 1885 to the new German rules (see NATURE, p. 89) adopted in 1892. Prof. Köppen has fully mastered his subject, and, from a thorough study of the phonetics of language, he has been able to formulate a scheme by which the Roman alphabet may be employed, with the aid of diacritical signs and groups of consonants, to represent almost every possible sound. The methods adopted in the official systems of the Royal Geographical Society and the German Colonial Office appear to the author of the pamphlet to be incomplete and unsatisfactory. The subject is one eminently adapted for full international discussion, and we hope that Prof. Köppen will not fail to bring the matter before the next international Geographical Congress.

POLAR exploration seems to have received a fresh stimulus, and we note with satisfaction the announcement in the American newspapers of Mr. Peary's new programme. He sails for Greenland in June, and will spend the winter not far from the site of his last winter's camp. A novelty in transport on the inland ice is to be the use of ponies shod with snow-shoes of a special pattern, experience in Alaska and Norway appearing to establish the practicability of the idea. The main object of the expedition is to survey the Arctic Archipelago immediately north of Greenland, and to determine the whole north coast of

the mainland. Mr. Peary has no theories, and expects to have to modify his plans according to circumstances. He expects to reach higher latitudes than have previously been attained, but has no sentimental views as to reaching the pole. The whole of the expense of the expedition he hopes to defray by his lectures and the book describing his last year's experience, which will be published in June.

STROMBOLI.[1]

ON June 24, 1891, an earthquake and volcanic explosion took place, followed by another shock on June 30. Some days after, the authors spent three days at Stromboli, and subsequently studied at their homes the materials they collected.

The paper commences with a description of the island, which not only adds nothing to what has already been published, but is inferior to what has been described by others. Mention is made of many changes during the last century, but great care is taken not to mention several writers who have described and illustrated the changes during the last few years. The writer, who was the first to photograph the crater of Stromboli, and has since published new photographs, is not even referred to, yet those photos are the best so far published of the volcano. It is regretable to see the frequency with which Prof. Mercalli quotes himself to the exclusion of several of his own countrymen, and especially foreigners. Since 1887, the single crater has been replaced by a number of cones which, according to the authors, are the same as those of 1889. I myself visited the crater in 1889, and those in the plates of this paper are very different in situation, which I can confirm by photos in my possession. The matter is of little importance, but more care should be shown in such statements. Those who have a good practical experience of active volcanoes know how often, from day to day these central conettes change.

The shock of the present eruption was quite local and was unobserved at Lipari. It was much more violent on the upper part of the mountain than lower down, and the authors reasonably conclude that the explosion was limited to the actual crater. Several landslips occurred on the crumbling slopes of the island. A column of vapour and lumps of incandescent lava were ejected to a level with the summit of the island, that is for a height of 225 m. Dust and lapilli were spread over the island though not to any great amount. Lava immediately began to flow from a short rift.

On June 30, another shock occurred, sufficiently strong to disturb the Milne seismoscopes of Lipari. After the usual ejection of lava cakes, lapilli, stones, &c., another lava stream started from a point near the eastern mouths. By July 6, when the authors visited the crater, the excessive activity had so diminished that no more lapilli or dust was being ejected. Three currents of lava flowed down the Sciarra to the sea, and as one divided into two branches, four reefs were formed at the water-line which it appears are being rapidly swept away by the waves.

The microscopic and chemical examination of the lava shows it to be a basalt verging on an andesite with 50 per cent. of SiO_2, with a little more potash than soda. The scoria ejecta resemble the lava in composition, except so far as their different rate of cooling modifies them. Besides the *essential*, some *accessory* ejecta were thrown out, which were old fumarolised materials from the new crater walls. The dust, or ashes, as the authors call it, was partly composed of black vitreous particles and glass fibres mixed with a brownish powder from the trituration of older volcanic materials.

No relation was found to exist between the eruptive spasm of Stromboli with several earthquakes that occurred before and after. A list of known eruptions of Stromboli are given, but it is a most imperfect one; for example the eruption of 1768, which was actually figured by Sir William Hamilton in his masterly work, is not even referred to, although lava not only issued from the crater, but also from a lateral opening on the western side of the Stromboli, and also was the first recorded issue of lava from this volcano. This list is more complete of late years, there being no less than fourteen eruptions from 1879 to 1888. Prof. Mercalli thinks there is a sympathetic action between the outbursts of Stromboli and Etna, and also the seismic foci of South Italy. He likewise finds a faint relationship between the position of the sun and moon when in opposition and conjunction but not with barometric pressure, but says that the daily variation in activity may so be related, as stated by the inhabitants.

H. J. JOHNSTON-LAVIS.

[1] "Sopra il perii odo eruttivo dello Stromboli cominciato il 24 Guigno, 1891." By A. Ricco and G. Mercalli. Con appendice dell' Ing. S. Arcidiacono. *Ann. d. Ufficio C. Met. e Geodinamico* ser. sec., pt. iii. vol. xi. 1889. (Paper printed 1892.)

FORTHCOMING SCIENTIFIC BOOKS.

MR. MURRAY has in preparation:—"The Life of Prof. Owen," based on his correspondence, his diaries, and those of his wife, by his grandson, the Rev. Richard Owen, with portraits and illustrations, 2 vols.; "Alone with the Hairy Ainu; or, 3,800 Miles on a Pack Saddle in Yezo and a Cruise to the Kurile Islands, by A. H. Savage Landor, with map and numerous illustrations by the author; "A Manual of Naval Architecture," for the use of officers of the navy, the mercantile marine, ship-owners, ship-builders, and yachtsmen, by W. H. White, F.R.S., third edition, thoroughly revised and in great part re-written, with 150 illustrations; "The Physiology of the Senses," by Prof. John McKendrick and Dr. Snodgrass, with illustrations (1) touch, taste, and smell (2) the sense of sight (3) sound and hearing; "Chapters in Modern Botany," by Prof. Patrick Geddes, with illustrations; "The Philosophy of the Beautiful, Pt. II.," by Prof. Knight; "Logic, Inductive and Deductive," by Prof. William Minto; "The Metallurgy of Iron and Steel," by the late Dr. John Percy, F.R.S., a new and revised edition, with the author's latest corrections, and brought down to the present time, by H. Bauerman, with illustrations.

Messrs. Longmans announce:—"Theosophy or Psychological Religion," the Gifford lectures delivered before the University of Glasgow in 1892, by Prof. F. Max Müller; "Telephone Lines and their Properties," by Prof. W. J. Hopkins; "Essays on Rural Hygiene," by Dr. George Vivian Poore; "Abdominal Hernia," by John Langton, M.R.C.S.; "A Treatise on Electricity and Magnetism," by G. W. De Tunzelmann in 2 vols.; "Papers and Notes on the Glacial Geology of Great Britain and Ireland," by the late Prof. Henry Carvill Lewis, edited from his unpublished MSS., with an introduction by Dr. Henry W. Crosskey; "The Making of the Body, a Reading Book for Children on Anatomy and Physiology," with many illustrations and examples, by Mrs. S. A. Barnett; "A Manual of Machine Drawing and Design," by David Allan Low (Whitworth scholar) and Alfred William Bevis (Whitworth scholar), with over 700 illustrations; "Diseases and Injuries of the Teeth, including Pathology and Treatment," a manual of practical dentistry for students and practitioners, by Morton Smale, M.R.C.S., and J. F. Colyer, L.R.C.P.; "Cotton Weaving and Designing," by John J. Taylor; "Clinical Lectures on Abdominal Hernia," chiefly in relation to treatment, including the radical cure, by William H. Bennett, F.R.C.S., with twelve diagrams in the text; "The Elements of Bacteriology," a manual for practitioners and students, by Prof. S. L. Schenk, translated by Dr. W. R. Dawson, with 100 illustrations, some of which are coloured; "Esquimaux Life," by Fridtjof Nansen, translated by William Archer, with illustrations.

Among Messrs. Macmillan and Co.'s announcements are:—"William Kitchen Parker, F.R.S," a short memoir by his son, Prof. T. Jeffery Parker, F.R.S.; "Text-book of Pathology: Systematic and Practical," by Prof. D. J. Hamilton, Vol. II.; "A Uniform Edition of Prof. Huxley's Essays," in 6 vols., comprising Lay Sermons, Addresses and Reviews, Critiques and Addresses, Science and Culture, American Addresses, Man's place in Nature, &c.; "Lectures on Sanitary Law," by A. Wynter Blyth, M.R.C.S.; "A Text-book of the Physiological Chemistry of the Animal Body," including an account of the chemical changes occurring in disease, by Prof. Arthur Gamgee, F.R.S., with illustrations, Vol. II.; "Tables for the Determination of the Rock-forming Minerals," compiled by Prof. F. L. Loewinson-Lessing, translated from the Russian by J. W. Gregory, with a glossary added by Prof. G. A. J. Cole; "Text-book of Geology," by Sir Archibald Geikie, F.R.S., with illustrations, third edition, thoroughly revised; "Atlas of Classical Antiquities," by Th. Schreiber, edited for English use by Prof. W. C. F. Anderson; "The Soil in Relation to Health," by Henry A. Miers and Roger Crosskey; "Elementary Treatise on Modern Pure Geometry," by R. Lachlan;

"Exercises in Euclid," by William Weeks; "Utility of Quaternions in Physics," by Alexander McAulay.

In the Clarendon Press list are:—Locke's "Essay concerning Human Understanding," edited by Dr. A. C. Fraser; "Mathematical Papers of the late Prof. Henry J. S. Smith, with portrait and memoir, two volumes; "A Supplementary Volume to Prof. Clerk Maxwell's Treatise on Electricity and Magnetism," by Prof. J. J. Thomson, F.R.S.; "A Manual of Crystallography," by Prof. M. H. N. Story-Maskelyne, F.R.S.; "Analytical Geometry," by W. J. Johnston; "A Treatise on the Kinetic Theory of Gases," by Dr. H. W. Watson, new edition; "An Elementary Treatise on Pure Geometry," with numerous examples, by J. W. Russell; "Index Kewensis Nominum Omnium, Generum et Specierum, Plantarum Phanerogamarum,' '1735–1885, Part I.; "Hospital Construction," by Sir Douglas Galton, F.R.S.

Messrs. Swan Sonnenschein and Co.'s list contains:—"Philosophy and Political Economy in their Historical Relations," by Dr. James Bonar; "Appearance and Reality," by F. H. Bradley; "The Principles of Psychology," by G. F. Stout; "History of Philosophy," by Dr. Johann Eduard Erdmann, translated and edited by Prof. Williston S. Hough, third edition, revised, three volumes; "A Student's Text-Book on Botany," by Prof. Sidney H. Vines, F.R.S., copiously illustrated; "Text-book of Embryology: Invertebrates," by Drs. Korschelt and Heider, translated and edited by Dr. E. L. Mark and Dr. W. M. Woodworth, fully illustrated; "The Cell: its Anatomy and Physiology," by Dr. Oscar Hertwig, translated and edited by Dr. H. J. Campbell, fully illustrated; "Text-Book of Palæontology for Zoological Students," by Theodore T. Groom, fully illustrated; "Lectures on Human and Animal Psychology," by Prof. Wilhelm Wundt, translated and edited by James Edwin Creighton and Edward Bradford Titchener; "Hand-book of Systematic Botany," by Prof. E. Warming, translated and edited by M. C. Potter, fully illustrated; "An Elementary Treatise on Practical Botany," by Prof. E. Strasburger, translated and edited by Prof. W. Hillhouse, with 149 illustrations, third edition; "The Photographer's Pocket Book," by Dr. E. Vogel, translated by E. C. Conrad, with 63 illustrations; "How Nature Cures," by Dr. Emmet Densmore; "Beauty and Hygiene for Women and Girls," by a Specialist; "A Popular History of Medicine," by Edward Berdoe, M.R.C.S.; "Introduction to the Study of the Amphioxus," by Dr. B. Hatschek and James Tuckey, illustrated; "Practical Bacteriology," by Dr. Migula, translated and edited by Dr. H. J. Campbell, illustrated; "Geology," by Dr. Edward B. Aveling, illustrated with a Geological Map and numerous woodcuts; "Zoology," by B. Lindsay, illustrated; "Fishes," by the Rev. H. A. Macpherson; "Flowering Plants," by James Britten; "Grasses," by W. Hutchinson; "Mammalia," by the Rev. H. A. Macpherson.

Messrs. George Philip and Son will publish:—"Philip's Atlas Guide to the Continent of Europe," a series of 72 plates, with descriptive letter-press, by J. Bartholomew; "Philip's Systematic Atlas for Higher Schools and General Use," a series of physical and political maps, with diagrams and illustrations of astronomy and physical geography, by E. H. Ravenstein; "Philip's Anatomical Model of the Human Body," illustrating the construction of the Human Frame and the relative positions of its various organs by means of superimposed plates printed in colours; "The Celestium, or Patent Astronomical Calendar for recording and illustrating in miniature the daily and hourly positions of the heavenly bodies as they pass through the Sign of the Zodiac."

Messrs. Percival and Co. give notice of:—"The School Euclid," an edition of Euclid, Books III. to VI., with notes and exercises, by Daniel Brent; The Beginner's Text Books of Science: "Chemistry," by G. Stallard; "Geology," by C. L. Barnes; "Electricity and Magnetism," by L. Cumming; "Heat," by G. Stallard; "Light," by H. P. Highton; "Mechanics" (treated experimentally), by L. Cumming; "Physical Geography," by C. L. Barnes; "Practical Physics," an introductory handbook for the physical laboratory, in three parts, by Prof. W. F. Barrett; Part II. Heat, Sound, and Light. Part III. Electricity and Magnetism, Electrical Measurements; "Practical Lessons and Exercises in Heat for use in schools and Junior University classes, by A. D. Hall.

In Messrs. A. and C. Black's announcements we notice:—"Illustrated Text-Book of Invertebrate Zoology," by A. E. Shipley; "History of Astronomy during the Nineteenth Century," by Agnes M. Clerke, third edition, revised and enlarged; "Algebra, an Elementary Text-Book for the Higher Classes of Secondary Schools and Colleges," by Prof. George Chrystal, Part I., third edition.

Messrs. Crosby Lockwood and Son have in hand:—A new and enlarged edition (the third) of Prof. R. Wallace's "Farm Live Stock of Great Britain," containing additional phototype engravings of notable specimens of live stock; and a new volume by Prof. Sheldon on "British Dairying."

Mr. Walter Scott will issue in the "Contemporary Science Series":—"Modern Meteorology," by Dr. Frank Waldo, with 112 illustrations.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Oxford.—Two Radcliffe Travelling Fellowships, each of the value of £200 per annum, and tenable for three years, have been awarded this week. One, which has been gained by Mr. E. A. Minchin, of Keble College, was thrown open last year to candidates in all branches of science, and the usual declaration that the Fellow intends to graduate in medicine and to travel abroad with a view to his improvement in that study has been dispensed with. Mr. Minchin was placed in the first class in the Honour School of Natural Science (Morphology) in 1890. The other Fellow, Mr. W. Ramsden, of Keble College, is subject to the usual conditions attached to these Fellowships. Mr. Ramsden obtained a first class in Natural Science (Physiology) in 1892.

The new laboratories for the department of human anatomy are rapidly approaching completion, and will, when finished, add very much to the convenience and advantages of medical students. The buildings have been designed after the plans of Mr. Arthur Thompson, and include a large dissecting room and several additional laboratories and private rooms, a lecture theatre, and a large basement.

Cambridge.—The Council of the Senate report that the Royal Geographical Society have renewed their generous offer to provide £150 a year as part of the stipend of a geographical lecturer for the ensuing five years, and to award biennially exhibitions or prizes for the encouragement of geographical research in the University. The Council recommend that the proposals of the society be accepted, and that a lecturer be appointed, under the supervision of a joint committee of management, before the end of the Easter Term, 1893.

The Sedgwick Memorial Syndicate report that they have made certain alterations in the plans for the proposed Geological Museum in Downing Street, with a view to meeting objections that were raised and to reducing somewhat the cost of the building. The Syndicate ask to be authorised to obtain tenders for the immediate construction of the museum.

SCIENTIFIC SERIALS.

American Meteorological Journal, February.—Hot winds in Texas, May 29 and 30, 1892, by I. M. Cline. Hot winds occur to some extent every year, but rarely with sufficient intensity to injure vegetation. It was estimated that in the present case 10,000 acres of cotton were destroyed, and corn suffered severely. The temperatures reported ranged generally from 90° to 100°, and in some parts from 105° to 109°. These winds appear to have resulted from the same causes which produce the Föhn in Switzerland, the descent of dry air which has deposited its vapour during its ascent.—The electrification of the lower air during auroral displays, by A. McAdie. The author gives an account of some experiments made at Blue Hill observatory, for obtaining, by means of a kite flown during thunderstorms, a better record of the potential of the air than could be given by a collector near the ground, by which plan some remarkable results were obtained, and he suggests similar experiments for showing the electrification of the lower air during displays of aurora. He also proposes a new classification of the various auroral phenomena, distinguishing between the highly coloured displays, and those of less intensity, which probably occur in the lower atmosphere.—Practical koniology, by Prof. Cleveland Abbe. He applies this term to the study of atmospheric dust and floating germs, and shows how their injurious effects on

certain industries may be obviated.—The sling psychrometer, by Prof. H. A. Hazen, and the aspiration *versus* the sling psychrometer, by A. L. Rotch. Both papers deal with the comparative merits of the two instruments for balloon observations.

Wiedemann's Annalen der Physik und Chemie, No. 2.—Among the papers in this number are the following:—A modified astatic galvanometer, by H. E. J. G. du Bois and H. Rubens. To minimise the effects of disturbing vibrations as producing false oscillations about a vertical axis, the suspended system is given perfect "inertia symmetry" about the axis of the fibre, and all flat parts of it are distributed so as to have equal areas in two mutually perpendicular planes. Quartz fibres are used for suspension.—Bolometric investigations of the grating spectrum, by F. Paschen.—The fundamental law of complementary colours, by Paul Glan. To determine the amount of light absorbed by the pigment of the yellow spot during transmission to the optically sensitive nerves, two candles of equal luminosity were observed with one eye through glasses of various colours, the one direct, and the other at such an angle that its image fell outside the margin of the yellow spot. The candles were shifted till both appeared equally bright, and their respective distances were measured. Taking the coefficient of absorption for red light as = 1, that for yellow (5828) was 0·889, for wave-length 5222 it was 0·171, 4856 (blue) 0·269, and for white light 0·424. In this way the conclusion was arrived at that the intensities of complementary colours reaching the retina must be equal in order to give the impression of white.—Experiences with the self-acting mercury pump, by A. Raps. Several improvements are described, tending to make the working more rapid. It was found that the fear of contaminating the mercury by the use of black flexible india-rubber tubes was unfounded.

SOCIETIES AND ACADEMIES.

LONDON.

Entomological Society, February 22.—Mr. Henry John Elwes, President, in the chair.—Mr. F. J. Hanbury exhibited, on behalf of Mr. Percy H. Russ, of Sligo, several long and very variable series of *Agrotis tritici*, *A. valligera*, and *A. cursoria*, together with Irish forms of many other species, some of which we believe to be new to Ireland. Mr. W. H. B. Fletcher made some remarks on the species.—Mr. R. W. Lloyd exhibited specimens of a species of *Acarus* found in New Zealand wheat. He stated that Mr. A. D. Michael had examined the specimens, and pronounced them to belong to *Tyroglyphus farinæ*, a species which had been known for over a hundred years as a destroyer of corn, and was only too abundant all over Europe, and probably over the temperate regions of the world.—Mr. E. B. Poulton, F.R.S., exhibited, and made remarks on, a number of cocoons of *Halias prasinana*, in order to show the changes of colour produced in them by their surroundings; he also exhibited the coloured backgrounds employed by him in his recent experiments on the colours of larvæ and pupæ, and illustrated his remarks by numerous drawings on the blackboard.—Dr. T. A. Chapman exhibited by means of the oxy-hydrogen lantern, photographs of the larva of *Nemeobius lucina* in its first stage, showing the conjoined dorsal tubercles, each carrying two hairs, which are remarkable in being divided into two branches. For comparison he also showed, by means of the lantern, drawings of the young larva of *Papilio ajax*, after Scudder, and of a portion of a segment of *Smerinthus populi*, as the only instances known to him of similar dichotomous hair sin lepidopterous larvæ. Mr. Poulton pointed out that he had described the forked hairs of *Smerinthus* in the Society's "Transactions" for 1885, and that such hairs were even better developed in the genus *Hemaris* originally described, as he believed, by Curtis. Mr. Poulton, also said that he had noticed similar forked hairs covering the newly-hatched larvæ of *Geometra papilionaria*.—Dr. Chapman read a paper—which was illustrated by the oxy-hydrogen lantern—entitled "On some neglected points in the structure of the Pupa of Heterocerous Lepidoptera and their probable value in classification." A discussion ensued, in which Mr. Poulton, Mr. Champion, and Mr. Merrifield took part.—Dr. F. A. Dixey communicated a paper entitled "On the phylogenetic significance of the variations produced by differences of temperature on *Vanessa atalanta*." The President, Mr. Merrifield, Mr. Poulton, Dr. Chapman, and Mr. Tutt took part in the discussion which ensued.

Zoological Society, February 28.—Sir W. H. Flower, F.R.S., President, in the chair.—Mr. A. D. Michael exhibited some specimens of the *Ixodes*, known locally in the West Indies as the "St. Kitts" or "Gold Tick," received from Mr. C. A. Barber, of the Agricultural Department, Antigua.—A communication was read from M. A. Milne-Edwards respecting *Lemur nigerrimus*, Sclater, a species of lemur originally described from an example living in the Society's Gardens. It was pointed out that *Prosimia rufipes* of Gray had been based on a female of this species.—Mr. Howard Saunders exhibited and made remarks on a specimen of the American stint (*Tringa minutilla*), shot at Northam Burrows, North Devon, by Mr. Broughton Hawley, in August, 1892.—Mr. Sclater (on behalf of Mr. R. M. Barrington) exhibited a specimen of the Antarctic Sheathbill (*Chionis alba*), killed at the Carlingford Lighthouse, co. Down, Ireland, in December last.—Dr. C. J. Forsyth-Major read a memoir on some of the miocene squirrels, and added remarks on the dentition and classification of the *Sciuridæ* in general. The author proposed a new division of this family into three subfamilies—Sciurinæ, Pteromyinæ, and Nannosciurinæ. The genera *Spermophilus* and *Arctomys* and the allied forms were united to the Sciurinæ. The last part of the paper dealt with the primitive type of the Sciurine molar.—Mr. Henry O. Forbes read a paper entitled "Observations on the Development of the Rostrum in the Cetacean Genus *Mesoplodon*. with remarks on some of the Species." Mr. Forbes showed that in this genus the vomerine canal in the young animal is filled with cartilage, and in the adult with a dense petrosal mesorostral bone. From the examination of thirteen specimens of *Mesoplodon grayi* and four of *M. layardi*, of which he had made a large number of sections in various stages of growth, the author concluded that the mesorostral bone was not, as had been generally believed, an ossification of the cartilage, but an actual growth of the vomer and of the premaxillaries, with perhaps, in some cases, additions from the ossification of the cartilage of the vomerine spout. The cause of the growth in the vomer might be accounted for by the pressure communicated to it by the growth of the premaxillaries, induced, perhaps, by the movement, which appears to take place, of the maxillaries over the premaxillaries.

Linnean Society, March 2.—Prof. Stewart, President, in the chair.—Mr. Miller Christy exhibited some photographs of the American bison taken from living wild animals, and gave some account of the present restricted distribution of the species. Mr. A. G. Renshaw and Mr. W. Carruthers detailed what they had been able to learn respecting it while travelling in its former haunts.—Mr. J. M. Macoun gave an account of the flora of the Behring's Sea Islands from personal exploration.—On behalf of Mr. H. N. Ridley the Secretary read a paper on the flora of the eastern coast of the Malay archipelago.—The meeting then adjourned to March 16.

Anthropological Institute, February 21.—Prof. A. Macalister, F.R.S., President, in the chair.—A paper, by Mr. E. H. Man, on Nicobar pottery was read. He stated that the little island of Chowra has held for generations a monopoly of the manufacture. Preparing the clay, and moulding and firing the finished utensil, devolves on the females. The value of trade marks is recognised, the device of its maker being affixed to each vessel. Experience having taught them that pots are more serviceable if allowed to harden gradually, they store newly-made utensils on a lattice platform in the roofs of their huts. In a year the heat and smoke render them hard and durable. Indian pots and jars are readily purchased from the traders, who occasionally visit the islands; but they are deemed unsuitable for certain culinary operations. There are no special vessels made for funeral purposes; but, in accordance with the almost universal custom of uncivilised races, cooking pots are among the personal and household requisites which are laid on a grave after an interment.—A paper, by Lieut. Boyle, T. Somerville, R.N., on some islands of the New Hebrides was read. The habits of the natives of adjacent islands sometimes vary exceedingly, and in this paper reference was made only to a small portion of the group, including the Efate Islands, the Shepherd Islands, and the East Coast of Malekula. A child calls all his uncles on both sides, "father," all his aunts, "mother," and his first cousins on both sides, "sister" or "brother." A man cannot marry a woman of his own tribe, and the children belong to their mother's tribe; the property of their father going, at his death, to his sister's children. It sometimes happens that a man will

call a small girl much younger than himself "mother." Circumcision takes place between the ages of five and ten. Till then a boy goes naked; but afterwards he is costumed like the men. When a Malekulan is old and decrepit, he has nothing to look forward to but burial alive. Should an old person become bedridden, or a burden, he or she is told quite simply that his or her burial will occur on such a day. Invitations to the funeral feast are then sent out, and, dead or not dead, on that date the unhappy person is buried.

PARIS.

Academy of Sciences, February 27.—M. de Lacaze-Duthiers in the chair.—On the attempt at oyster culture in the Roscoff laboratory, by M. de Lacaze-Duthiers. In April, 1890, a set of seed oysters were introduced into a tank in the grounds of the observatory, which lies opposite Batz Island, in the Channel. They were always submerged, but exposed to tidal changes of level. In a year they had acquired a considerable size, but had not yet "fattened." Last November they had a size and flavour which, in M. Chatin's opinion, surpassed the qualities attained in any other locality along the coast, although in the warmer months preceding (the months without R) they had shared the decline common to all oysters at that period. It was also found that the oysters in the tank acquired longer "beards," and also increased in length, whilst others cultivated on the shores of Batz Island, and often left dry at low water, were more developed in the direction of thickness. As regards reproduction, the results have been fairly favourable, although definite data have not yet been obtained. In one case, where part of the tank water had been pumped into a reservoir used for supplying an aquarium, some embryos were drawn up through the pipes, and fixed themselves on the wooden level-ball, where a colony of about a dozen well-developed oysters was subsequently found, some of which now measure 6 cm. across.—On the exact determination of the pepto-saccharifiant action of the organs, by MM. R. Lépine and Metroz.—On the photographs of the moon enlarged by Prof. Weinek, by M. Faye. These photographs are enlargements by twenty times of some of the Lick photographs of the moon, obtained by an exposure lasting several days. On their being exhibited, several members expressed their opinion that they had been retouched.—On the urea contained in the blood in cases of eclampsia, by M. L. Butte. It is found that in cases terminating fatally the amount of urea contained in the blood is less than in cases of recovery, owing to hepatic alterations, which in the former cases impair the secretion of urea. From the point of view of prognostication, therefore, recovery can be anticipated if the amount of urea is two or two and a half times the normal amount, but a fatal issue if the amount closely approximates to the physiological figure.—On the general problem of integration, by M. Riquier.—On certain differential equations of the first order, by M. Vessiot. — Remarks concerning a preceding note on a generalisation of Lagrange's series, by M. E. Amigues. — Physical properties of fused ruthenium, by M. A. Joly (see Notes).—On Stas's determination of the atomic weight of lead, by M. G. Hinrichs. In Stas's determinations of the atomic weight from the sulphate and the nitrate the weight of substance taken, according to M. Hinrichs, enters as a continuously changing element into the result, owing to a systematic error in Stas's arrangement. In plotting the atomic weights in terms of weight of substance taken, curves are obtained showing a minimum at about 150 gr. The method of averages is therefore inadmissible, and a new method is promised in a forthcoming communication.—On the aldehydes of the terpenes, by M. A. Étard.—On the constitution of hydrated alkaline phenates, by M. de Forcrand.—On the alkaloids of cod-liver oil, their origin and therapeutic effects, by M. J. Bouillot.—On a pathogenic microbe of blennorhagic orchitis, by MM. L. Hugounenq and J. Eraud.—Crustacea and cirrhipeds commensal with the Mediterranean turtles, by MM. E. Chevreux and J. de Guerne.—On a terrestrial leech of Chili, by M. Raphael Blanchard. This animal, which has been named *Mesobdella brevis*, forms a link between the Glossiphonidæ and the Hirudinidæ. Among the latter it approaches most closely the Hemadipsinæ by its mode of living and its ten large black eyes, but differs from the whole family by the great condensation of its somites.—Mineralogical and lithological examination of the meteorite of Kiowa county, Kansas, by M. Stanislas Meunier. The metallic portion presents two principal alloys of iron and nickel, which an attentive study has succeeded in characterising: Tænite (Fe_6Ni) and plessite ($Fe_{10}Ni$). In composition it agrees closely with the entirely metallic type called jewellite, but it differs from the latter in structure. Apart from the peridotic portions the mass consists of lamellæ of tænite arranged in bundles which frequently intersect at the angles of the octahedron. The intervals are filled up with plessite which may be distinguished at once by its dark-grey colour, contrasting with the polished steel tint of the other alloy. Some specimens of the meteorite show quite exceptional characters. With the usual structure and cohesion they are formed of opaque black mineral grains cemented by a network of oxidised iron. These have probably been produced by an alteration of the normal specimens, in which the metallic skeleton has been oxidised.

GÖTTINGEN.

Royal Society of Sciences.—From July 27 to December 28, 1892, the following papers of scientific interest have appeared in the *Nachrichten*:—

July.—Drude: Current theories of light practically tested.—Ehlers: On *Arenicola marina*, L. (five pages).—Rhumbler: The so-called germ-spherules (Max Schultze) of *Foraminifera* (these are stated to be merely deposits of iron silicates).—Nernst: The change of free energy in the mixture of concentrated solutions.—Hilbert: Third note on algebraical invariants.

September.—Fricke: A general arithmetical principle in the theory of automorphic functions.—Kohlrausch: On the influence of time upon solutions of sodium silicates.

November.—Peter: Botanical work in the summer of 1892.—Voigt: On a problem in fluid motion.—Sella and Voigt: The rupture coefficient of rock salt.—Kallius: The neuroglia-cells of peripheral nerves.

December.—Wagner: The third (Peter Apian's) map of the world (1530).

CONTENTS.

THURSDAY, MARCH 16, 1893.

MACPHERSON'S FAUNA OF LAKELAND.

A Vertebrate Fauna of Lakeland, including Cumberland and Westmoreland, with Lancashire North of the Sands. By the Rev. H. A. Macpherson, M.A., with a Preface by R. S. Ferguson, F.S.A. (Edinburgh: D. Douglas, 1892.)

INTRODUCED to the vocabulary of naturalists by Mr. H. Cottrell Watson, more than fifty years ago, and that in the most prosaic way, the word "Lakes," as the name of an English district, still keeps its poetic fragrance, which is perhaps even intensified by its modern modification into "Lakeland," notwithstanding the very technical prefix, as in the title of this book, of "A Vertebrate Fauna." One is naturally led to think of that school of versifiers whose early efforts excited so many conflicting feelings when the century was young, but whose later lays have at length brought conviction of their worthiness to the minds of most. One of their company, he who furnishes the motto of this journal, has especially been hailed as *the* Poet of Nature, and not only does the fame of Wordsworth wax yearly, but there are those who greet every line he wrote with adulation. To such admirers the author of the book before us will seem to have missed his opportunity, in that we fail to find in the whole volume any indication of the penultimate Poet Laureate having ever belonged to the "Vertebrate Fauna of Lakeland." Does this signify that naturalists are not poetical or that the great "Poet of Nature" was not a naturalist? The question is so momentous that we leave it for consideration by our readers, not daring to vouchsafe a reply, nor venturing to suggest to Mr. Macpherson that he has been wrong in resisting the temptation to illustrate his work by quotations, that might be gathered by the handful from the thousands of verses which flowed from the pen of the "bard of Rydal," or any of his brethren.

We must acknowledge that we took up this volume with a slight prepossession against it. We did not see why Mr. Macpherson, already the joint author of a well-known and well-esteemed little book on the "Birds of Cumberland," to say nothing of various contributions to Natural History journals, should need a preface for his new work by a gentleman who—whatever may be his legal and antiquarian renown (which we believe to be not small)—is entirely unknown as a naturalist, and it seemed to us as though a kind of sub-episcopal *imprimatur*, which would be derogatory to a man of science, had been sought from the Chancellor of the diocese of Carlisle. We have been glad to find this suspicion, perhaps ill-natured in its inception, wholly unfounded as we became acquainted with the contents, and we hereby make confession of our error, duly cautioning all others, and there may be a good many of them to whom the same thought may occur or have occurred, that any such hesitation is unnecessary. The Preface, it is true, contains a benediction, but none can say it is a benediction that is undeserved. The book is a real honest book, and one that no true zoologist can fail to discover has been wrought at with conscientious care, unbounded labour, and a deep sympathy with the subject. We are not going to hold it up as a model "Fauna"; there is evidence, notwithstanding what we have just said, of too much haste in its composition for that; but it certainly belongs to the first class of books of its kind, while, should it be the author's good fortune to have another edition demanded, a severe revision might give it a high place in that class. We do not assume ourselves to be purists in style, but it does seem to us that the English language, as written by men of acknowledged literary merit, is wide enough to cover every shade of meaning, without the least necessity of bringing in words or phrases that border upon slang, and certainly without using slipshod expressions that, if not altogether inappropriate, are in many cases vague and therefore unseemly in a book that may fairly claim to rank among scientific works. We assure the author in all good will that these shortcomings, which might be so easily remedied, greatly diminish the pleasure we derive from reading his volume.

Apart from Mr. Ferguson's scholarly Preface, the book opens with more than one hundred pages of Prolegomena, and we are mistaken if the greater part of these will not prove to have greater interest for that incomprehensible person the General Reader than all that follow—the particulars given in the bulk of the volume being mostly of especial and local value. Not that we use this last epithet in any invidious sense, for what should a local Fauna be but local? and Mr. Macpherson has avoided a great error (into which the authors of some modern local Faunas have fallen), by rightly taking it for granted that the zoological readers who will use his book do not want to be instructed on points or matters concerning which they can obtain full information from many other and more original sources, and thus he is able to husband his space for particular details, which are given in most cases with great precision. But first of these Prolegomena aforesaid—They begin, as every book of this sort ought, with what is practically a history of the subject; for it is a biographical notice of former Lakelandish worthies who have contributed to the Vertebrate Zoology of their district, and of these there is a good show; though there is no wonder that the earliest writers on the subject should possess but little scientific knowledge. It is not every county that can produce a Willughby, a Sir Thomas Browne, or still less a John Ray—but probably the earliest of the naturalists celebrated by Mr. Macpherson were the equals of Charleton, Plot, or Leigh—all men worthy to be praised in their own line. Yet setting aside these lesser lights, many of whom are lost to view in the glare that radiates from their successors, the two Heyshams (John, born 1753, died 1834, and Thomas Coulthard, born 1791, died 1857), and the two Goughs (John and Thomas, whose joint lives cover all but a century and a quarter, 1757–1880)—in each case father and son—were men deserving commemoration in any county, and the biographical notice of all four, written in excellent taste, will be gladly read by many who are not naturalists at all. For our own part we cannot help wishing that these biographical details had been longer; but the papers of the elder Heysham are not forthcoming, neither is the manuscript Cumberland Ornithology, which the younger is supposed to have left at his death. The former, if still

existing, would no doubt throw much light on more than fifty years of Cumbrian Natural History; but most likely everything of value in the latter was communicated to Bell or Yarrell, with whom its author was in frequent correspondence, and during his later years he led a life of seclusion. The elder Gough was an extraordinary instance of a naturalist successfully pursuing his vocation under a grave difficulty, for the like of which we can only call to mind Huber and M. Van Wickevoort-Crommelin, since at an early age he became blind from small-pox, and if he was thereby disabled from advancing investigation according to his bent, it did not hinder him from training his son to follow his footsteps and indoctrinating him with so wide an attachment to science that he became an intimate friend and correspondent of Sedgwick the geologist and of Cornelius Nicholson the antiquary, establishing with the latter's aid the Kendal Literary and Scientific Institution. The pious duty of celebrating his predecessors' obsequies being performed, Mr. Macpherson next turns to other extinct mammals of Lakeland, and his researches respecting the Wolf (an entire skeleton of which, found in a cave by Mr. John Beecham, is preserved in the museum at Kendal) and the Wild Boar have been rewarded by the discovery of documentary evidence not without interest, even if it does not add much that is of value to our information concerning these ancient beasts. We have too some facts in relation to the Red Deer and the Wild Ox, though more is said of them, and some of it is of importance, in the body of the work (pp. 50–76), and we do not see why the former at least of them should be called extinct, seeing that though greatly restricted in range it still exists in freedom, while the latter, whose right German name Mr. Macpherson persistently curtails, misspelling it "Auroch" for *Aurochs*, was undoubtedly the ancestor of the white breed, of which the last herd in the district, having been emparked at Thornthwaite near Haweswater, was removed in or soon after 1630 to Naworth, and by 1675 had ceased to exist. A chapter devoted to "The Destruction of Wild Animals" will be instructive reading to many people. It contains what will be a revelation to those who can appreciate the facts of "how not to do it." Our excellent forefathers (and many of their descendants are not much wiser) knew very little of the way in which wild beasts could be extirpated, and consequently the warfare against them lasted for centuries. Some few, still accounted enemies of the human race, yet defy their persecutors; but the greater number have perished, and in the present depleted state of the Mammalian Fauna of the British Islands, it would be inexpedient to point out how the extinction, at least in parts, of some two or three species might be accomplished in perhaps twice as many years. The average gamekeeper (fortunately or not) has very little knowledge of zoology, and the average master even less. On this particular we have no wish to enlighten either, so we shall preserve a silence that all animals' friends will admit to be golden. But we must always remember that by far the most destructive four-footed "vermin" of our day is religiously and rigorously preserved by a general sentiment, so much stronger than any law, in a way that would have caused to wonder those who "kenned John Peel" and his forefathers. In favour of Mr Macpherson's next treatise on the Variation of colour in Animals not much is to be said, and this *capitulum* will disappoint most who consult it, while we take leave to observe that though many authorities are cited from the *Carlisle Patriot* of these times to Dr. Caius of 1570, that learned man assuredly never wrote a book with a title so tautological as "*De rariorum animalium et avium stirpibus*," which must have been taken (p. lxxvi, note) at second hand from one of the popular writers, who imagine that birds are not animals and do not know the technical meaning of *stirpes*. Albinescent specimens if not albinos have, it is well known, a great charm for some collectors—why, scarcely any reasonable being can say—and it is of them that our author chiefly discourses (using too a word—"leucotism"—quite unfamiliar, but apparently meaning the same as the recognised "albinism") though so far as we know little scientific interest attaches to them; but we do not quite see the point of his remarks (p. lxxviii) on "the tendency in the direction of variation" of the Lakeland Viper. He only mentions two examples, and what are they among so many? Nevertheless the one figured is strange-looking enough, and it would have been satisfactory to be assured that there can be no mistake in the determination of the species. The succeeding chapter is devoted to Hybrid Birds; but here again we find not much of interest in a general way on that little-known and extremely interesting, not to say important, subject. Mr. Macpherson has been so fortunate as to see more than one wild hybrid between the two British species of Sparrow (*Pàsser domesticus* and *P. montanus*) and considering that these are species in what some would call the "physiological" sense—the sexes being outwardly alike in the latter and wholly different in the former—the question deserved further attention than is bestowed upon it (pp. lxxx—lxxxi).

More instructive is what follows on "Bird Fowling" (as the author redundantly terms it) or rather we should say more instructive it might be. There is mention (p. lxxxviii) of the netting of Razorbills and Guillemots on the rocks of St. Bees', taken, we are told, from the "Sandford MS. p. 18," but where this manuscript is to be seen or of what age it may be we are not told, and the language of the passage quoted only shows that it is not exactly of yesterday. Now the netting of *Alcidæ* is not, so far as we are aware, known to have been practised elsewhere in Britain, and Mr. Macpherson says the custom is obsolete in Cumberland, probably from there not being birds enough left to make its continuance worth the while of the "Hivites," for it may be accepted as a universal rule that the taking of birds at their breeding haunts year after year, unless under such conditions as St. Kilda presents, must end in their diminution and may easily be carried on to their extinction.

For the rest of the Prolegomena there is no need to say anything, and we willingly pass over the useless representation (p. xcvi) of the Polish Swan's trachea, though we congratulate Mr. Macpherson on being able to figure (p. ciii) the foot of a real Westmorland Sea-Eagle, not a mere "marauder from over the border"—as most of the examples killed in England are—but a mournful relic for all that.

Into the details of Lakeland species we shall not attempt to enter. To criticise that portion of the volume

the critic should have nearly as much local knowledge as the author, and we pretend to none. To some though not to a great extent the besetting sin of nearly all "Faunists" is evident, and that is the tendency to exalt the importance of the capture of stray individuals, this especially among birds. The occurrence of these wanderers is undoubtedly worth recording; but that a zoologist should claim consideration for Cumberland because a *Saxicola isabellina* was shot there, or for Furness because a *Pelagodroma marina* was washed up on Walney, is an indication that he takes rather a narrow view of things—though we are bound to admit that Mr. Macpherson at the same time descants on the merits of the Wheatear as a characteristic Lakeland bird; and, especially as befits one by descent "servile to *Skyey* influences", laments the almost complete absence from the Lakeland seas of the Manx Puffin, due no doubt to its extirpation in the neighbouring island, or its Calf, that gives it an English epithet nowadays inappropriate. Indeed there is no fault to find with our author in his sympathy for the *true* denizens of his district, and the highest praise is due to him for the labour he has exercised, of which almost every page bears witness, in telling their story. To wind up we must add, what perhaps we ought to have said before, that for the purpose of this work "Lakeland" consists of the counties of Cumberland and Westmorland, together with that part of Lancashire known as Lancashire Over-Sands, being identical, the Isle of Man excepted, with the "twelfth Province" of Mr. Watson's *Cybele Britannica*; but the want of a map of the entire district is a grievous drawback, for which even the dozen or more excellent etchings, showing as many places of interest, do not wholly make amends.

THE EVOLUTION OF DOUBLE STARS.

Die Entwickelung der Doppelstern-Systeme. Von T. J. J. See. 60 pp. (Berlin: R. Friedländer und Sohn, 1893.)

THE essay which we review is a dissertation for the doctorate of philosophy of Berlin, and the author, Mr. See, is an American, although he writes in German.

The component stars in double systems appear to be usually of comparable magnitudes, and are found to move in highly eccentric orbits. This case the author holds to be the normal one, whilst the solar system, with its one preponderant mass, and its nearly circular orbits, would be exceptional.

He attributes the observed high eccentricity of orbit to the influence of tidal friction, and accordingly the greater part of the paper is devoted to the consideration of the results which will ensue from the supposition that each of two bodies raises in the other tidal disturbances, which are subject to frictional resistance.

If the rotations of the two bodies differ in speed, the problem is an insoluble one, without some postulate as to the law of the frictional resistance. The author is, however, of opinion that sufficient insight may be gained from the solution in the case where two equal bodies rotate with equal speed. This opinion seems justifiable, but it might have been well if the dynamical stability of equality of rotations had been explicitly pointed out. That there is such stability is clear from the consideration that, if one of the bodies rotates more rapidly than the other, it is subjected to a more rapid retardation of rotation, and there is accordingly a tendency towards the restoration of equality.

The influence of tidal friction on the elements of the orbit of a satellite and on the rotation and obliquity of a planet have been investigated in my several papers, and Mr. See here adapts my conclusions to the case of the double tidal friction of two stars. The adaptation is not difficult, for whilst the rate of change in the rotation of each star remains the same as though the other did not rotate, the rates of change of the elements of the orbit are exactly doubled. Mr. See has then redrawn the curves which exhibit the gradual transformation of the system, and, as might have been expected, finds them to have features closely similar to those of my curves.

The generality of these solutions is limited by the supposed smallness of the eccentricity and of the inclinations of the orbit and of the two equators to the plane of reference. The author, however, then passes to a second case, which is more special in that the equators of the stars remain coincident with the plane of the orbit, but which is more general in that the eccentricity is not treated as being necessarily small. The object is to obtain a numerical solution of the following problem:—Two equal stars, each of three times the sun's mass, revolve in a nearly circular orbit at a distance equal to that of Neptune from the sun, and the rotation of each star is nearly equal to its orbital motion; it is required to find the greatest mean distance and the greatest eccentricity of orbit to which the system will change under the influence of tidal friction.

Mr. See solves this problem by methods analogous to those which I have employed, and finds that the mean distance will increase from 30 (Neptune's distance) to 50, and that the eccentricity will increase from an assumed initial value of one-tenth to a maximum of about three-fifths, which is attained a little earlier than the maximum of mean distance.

It may be remarked that these results can only be very rough approximations to the truth, because the calculation is conducted on the supposition that the moment of inertia of each star is the same as that of a homogeneous sphere of the same mass and radius, whereas it is obvious that the stars would really be highly condensed spheroids of great oblateness.

It is to be regretted that the calculation has not been repeated with variations of the assumed initial conditions. It is easy to see that a change in the assumed degree of concentration of the stars would give very different results. Supposing, for example, the stars had had only half the diameter assumed, the rotational moment of momentum would have had a quarter of its value in Mr. See's example. Now the enlargement of orbit is due to the transference of rotational to orbital moment of momentum, and thus the transferable moment of momentum would only have amounted to one quarter of its former value. But the orbital moment of momentum varies as the square root of the mean distance, and hence the enlargement of the orbit could not have been so much as one-sixteenth of its former value. We may feel sure that

the increase in the eccentricity of orbit would also have been largely reduced.

Notwithstanding this criticism, it appears to me that Mr. See fairly establishes the proposition that a high eccentricity is explicable by means of tidal friction.

Turning, then, to the question of the relative masses of the components of double star systems, Mr. See remarks with justice that the comparable brightness of the components renders it highly probable that the masses are also comparable, and he sees in certain results of M. Poincaré and of my own an evolutionary explanation of this fact.

Jacobi first showed than an ellipsoid of homogeneous fluid, with its three axes bearing to one another proper proportions, is a figure of equilibrium when it rotates about its smallest axis with a proper angular velocity. M. Poincaré next showed that if the length of the Jacobian ellipsoid exceeds the breadth in a certain ratio, the equilibrium becomes unstable, but that there is a stable figure which may be described as a Jacobian ellipsoid with a furrow nearly round the middle, so that it resembles an hour-glass with unequal bulbs. If we trace the further development of the hour-glass we find its neck gradually thinning, and finally rupturing the figure of equilibrium, henceforth consists of two detached masses.

My own attack on this problem was from the opposite point of view, for I endeavoured to trace the coalescence of a pair of detached masses so as to form an hour-glass or dumb-bell.

Mr. See reproduces the figures illustrative of both these investigations, and remarks that they both show that when there is a gradual detachment from a rotating figure of equilibrium, the detached portion will not normally be a ring, but that there will ensue two quasi-spheroidal masses of matter of comparable magnitude. He also remarks that if the fluid be heterogeneous, the ratio of the masses will be much smaller than when it is homogeneous.

In the discussion of these figures of equilibrium the wording of the essay appears a little careless, for it might naturally be supposed to mean that increase of angular velocity is a necessary concomitant of the rupture of the neck of the hour-glass. Now it is a somewhat paradoxical fact that, with constant density, the longer elongated figures of equilibrium rotate more slowly than the shorter ones, and it might therefore seem that the rupture of the neck should go with retardation of angular velocity. But it is the value of the square of the angular velocity divided by the density which determines the length of the elongated figures, and thus increase of density tells in the same way as retardation of angular velocity. In the history of a nebula the only condition for rupture which can be specified is that of contraction.

The probability of this view of the genesis of double stars is strikingly illustrated by a number of drawings by Sir John Herschel of various nebulæ. The great similarity between Herschel's nebulæ and the theoretical hour-glass is obvious. It may be hoped that in the book which Mr. See promises he will also illustrate this point by photographs.

Annulation is usually accepted as the mode of separation in the nebular hypothesis, but, as already stated, this is held by Mr. See to be exceptional. He thus regards the ring of Saturn as being as exceptional in its history as it now is in appearance. Where he maintains that Saturn's ring will never coalesce into a satellite, he might with advantage have referred to the remarkable investigations of M. Roche,[1] who showed that a satellite would be torn to pieces by tidal action if it revolved at a distance of less than 2·44 times the planet's radius. We may here note the interesting fact that whilst Saturn's ring almost touches "Roche's limit" on the inside, the Martian satellite, Phobus, and the fifth satellite of Jupiter[2] almost touch it on the outside.[3]

In order to prove his thesis as to the highness of the eccentricity and the comparability of masses, Mr. See gives a careful table of the observed elements of the orbits and of the relative brightnesses of seventy-three pairs of double stars. The values of the elements are of course open to much uncertainty, but the mean eccentricity, which is found to be ·45, must lie near the truth. In the few cases in which the masses have been determined, they are found to be comparable, and the comparability of the brightnesses confirms the generality of this law. Thus the facts of observation agree with our author's ideas.

Mr. See must be congratulated on having written an essay of great cosmogonical interest, and although his theory may never be susceptible of exact proof, yet there is sufficient probability of his correctness to inspire us with fresh interest in the observations of double stars.

G. H. Darwin.

MAGNETIC INDUCTION IN IRON AND OTHER METALS.

Magnetic Induction in Iron and other Metals. By J. A. Ewing, F.R.S. (London: *Electrician* Office.)

In this admirable book Prof. Ewing has brought together matter which was before to be found only in the journals of learned societies, and he has also given a full account of his own researches in magnetism. The book is written in a lucid style, and is supplied with numerous references to original papers.

In Chapter I. Prof. Ewing explains clearly the meaning of such terms as "intensity of magnetisation" and the like, which many students have difficulty in understanding. As stated in the preface, he has "endeavoured to familiarise the student with the notion of intensity of magnetisation (I) as well as with the notion of magnetic induction (B)." When endless magnetic circuits are discussed, it is convenient to talk of "permeability" and "induction"; on the other hand, "magnetic poles" and "magnetisation" are just as important when permanent magnets are dealt with. The magnetisation of ellipsoids and the influence of the shape and dimensions of magnetised bodies upon magnetic quality are fully treated.

1 "Acad. des Sciences de Montpelier," vol. i. (1847–50), p. 243. See also Darwin, *Harper's Magazine*, June, 1889.

2 The values given by Barnard (Nature, p. 377) make the distance 112,000 miles, and Roche's limit 107,000 miles.

3 It is proper to warn the reader that Roche's limit depends to some extent on the density of the planet. For the sun it will be about one-tenth of the earth's distance from the sun. Thus a body of planetary size cannot move in a highly eccentric orbit, so that its perihelion distance is one-tenth, without being broken up into meteorites; and conversely a flight of meteorites with less than the same perihilion distance can never coalesce into a planet.

Chapters II. and III. are devoted to measurements of magnetic quality by the magnetometer and ballistic methods. With respect to the former very full information is given as to the construction of the apparatus and its use.

The earth's coil as a means for calibrating the Ballistic Galvanometer is fully explained, as also that of a solenoid and current. Mention is not made of a convenient method of calibration in which the quantity of electricity passed is given directly by $Q = \frac{A}{a} \frac{\tau}{2\pi}$; where A is the deflection corrected for decrement; a is the steady deflection due to unit current, and τ is the periodic time of the ballistic needle. Here a and τ are quantities very readily obtained.

The chapter concludes with a full description of Dr. Hopkinson's "Bar and Yoke" method.

Chapter IV. contains valuable information with regard to curves of induction and hysteresis in the case of wrought iron, steel, and cast iron, which will be of use to the electrical engineer in the design of dynamo electric machinery. The effects of annealing and stretching iron are brought forward and well illustrated.

The next chapter, on magnetic hysteresis, is perhaps the most important in the book. It commences by giving a clear definition of hysteresis, the effects of which are amply illustrated by curves, and stress is laid upon the definition of permeability as being the ratio of B to H *with certain limitations*.

The dissipation of energy through magnetic hysteresis—which plays such an important part in the design of cores for transformers, and the armatures of dynamos—is fully treated.

The remarks on magnetic viscosity towards the end of the chapter are worthy of very careful consideration. The author points out that in the case of quick cycles, $\int H dI$ may be widely different from what is found to be the case by static methods, and further remarks that experimental evidence is wanting under this head.[1]

Chapter VI. treats of magnetism in weak fields. The author refers to experiments by Lord Rayleigh and himself, in which the time effect upon magnetism is clearly shown—the creeping up of the magnetism going on for a considerable time.

Magnetism in strong fields is discussed in Chapter VII. The "Isthmus Method" introduced by the author and Mr. W. Low in 1887 is capable of producing magnetic fields of enormous strength. In giving his conclusions from experiments by the isthmus method the author states, "there is apparently no limit to the value to which the induction may be raised. But, when we measure magnetisation by the intensity of magnetism I, we are confronted with a definite limit—a true saturation value, which is reached or closely approached by the application of a comparatively moderate magnetic force."

A full account of Dr. Hopkinson's researches on the effect of temperature on magnetism is given in Chapter VIII., and reference is made to the identification of recalescence with recovery of the magnetic state.

In the latter part of the chapter hysteresis, in the relation of magnetic susceptibility to temperature, is dealt with; and mention is made of the wide range of temperature through which the alloys of iron and nickel may exist in either the magnetic or non-magnetic state.

Reference is made to the researches on recalescence of Osmond, who has since shown the marked influence of the initial temperature, and the rate of cooling on recalescence in the case of chromium steel. Dr. Bottomley has shown that the alloys of chromium and steel in the unannealed state have exceptionally high magnetic qualities, which are confirmed by experiments of Dr. Hopkinson.

In Chapter X. the magnetic circuit is discussed, and the way in which it is applied to the design of dynamo electric machines and transformers. Reference is made to the important work of Drs. J. and E. Hopkinson and Kapp upon this subject—more especially in connection with dynamo electric machinery. In pursuing the analogy of the magnetic circuit to the ordinary conduction equation, Prof. Ewing lays stress upon the fact that the permeability (μ) is a function of the induction (B), and this is a point which cannot be too strongly urged. Much that is in this chapter has great practical importance—the treatment of the subject being considered from a graphical, as well as analytical, point of view. The chapter ends with an account of the influence upon magnetism by cuttings and the compression of joints in magnetic circuits.

The last chapter gives a complete account of the different theories of magnetism. Weber's theory is discussed with modifications by Maxwell and Wiedemann, to which are added Prof. Ewing's own views of the subject. He goes on to show that the reduction of hysteresis by vibration is explained by the molecular theory of magnetism,—and further supposes that time-lag in magnetism can be accounted for by it. The book ends with an account of Ampère's hypothesis of magnetic molecules.

E. WILSON.

OUR BOOK SHELF.

Forschungsberichte aus der Biologischen Station zu Plön. Theil I. Faunistische und biologische Beobachtungen am Gr. Plöner See. Von Dr. Otto Zacharias, Direktor der Biologischen Station. (Berlin: R. Friedländer und Sohn, 1893.)

THE first report of investigations from the biological station of Plön, in Holstein, has just been issued. It is a journal of 52 pages with one plate, bearing on the front of the cover a neat representation of the turreted three-storey building reflected in the quiet waters of the inland lake, and on the back a list of the regulations observed in the management of the station.

In his introductory remarks the Director, who has already made his views known with regard to the importance of freshwater laboratories in the pages of several German scientific periodicals, gives a brief sketch of the advance already made in this direction in Italy, France, and America.

The first paper gives a list of the fauna at present known to inhabit the lake. This occupies seven pages; and fourteen names, being printed in italics, signify that they are new to science. The new species and genera are treated in detail in the second paper. The greatest

[1] For recent experiments upon Magnetic Viscosity see a paper by J. Hopkinson, F.R.S., and B. Hopkinson in *Electrician*, September 9, 1892.

number occur amongst *Rotatoria*, but additions are also made to the *Rhizopods*, *Heliozoa*, and *Infusoria*. No new forms appear to have been found amongst the crustacea, mollusca, or fishes.

A third paper deals with the distribution and special natural history of the forms met with, and with the comparison of the plankton at different seasons.

There are no foot-notes through the number, but all references to literature are formed into a numbered table at the end. The plate, which is one of Klinkhardt's, of Leipzig, shows a number of the new forms discovered.

The investigations are almost entirely on the minute floating organisms, as must necessarily be the case at this date with all freshwater work not connected directly with pisciculture.

The British Journal Photographic Almanac for 1893. Edited by J. Traill Taylor. (London: Henry Greenwood, and Co., 1893.)

THIS annual volume contains, as usual, a vast amount of useful information gathered from workers in all the various applications of photography. After a brief summary, in which the editor refers to some of the chief advances made in the science of photography during the past year, mentioning, for instance, Mr. Dallmeyer's telephotographic lens, Mr. Willis's improvement in the platinotype process, &c., he devotes a few pages to "some photographic methods of book illustration." Then come short contributions in which everyone has something special to say, whether it relates to a new mounting medium, a permanent toning bath, or pinhole pictures, &c. They are far too numerous to mention individually, but will be found most interesting reading. "Epitome of Progress" is the title of a series of notes by Mr. Traill Taylor, in which he refers briefly, and in some cases at length, to new methods, remedies, &c., and instruments used in the practice of the art. The formulæ and tables are as numerous as ever, while all the other information, such as lists of photographic societies, &c., have been brought up to date. The volume is copiously illustrated.

Studies in Corsica. By John Warren Barry, M.A. (London: Sampson Low, Marston, and Co., 1893.)

MR. BARRY has twice visited Corsica, the first visit being of less than five months' duration, while the second extended from September 1882 to February 1885. He has thus had ample opportunities for the study both of the island and of its people, and in the present volume he sums up his impressions very brightly and pleasantly. Most readers will probably like best the chapters on life at Ajaccio, but they will also find much to interest them in what the author has to say about the Bush of Corsica and of the Mediterranean region.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Luminous Earthworms.

I HAVE recently received from a correspondent a statement which is sufficiently valuable to crave public attention. It opens up withal a very fascinating field of investigation, and one which, though it has by no means been altogether neglected by foretime naturalists, is as yet far from being fully understood.

Writing from Richmond, Surrey, the Rev. Alfred Geden, M.A., says:—"I have just heard of a phenomenon in the worm world which is new to me . . . My sister declares that one day last summer, in a village on the Thames, she saw a 'phosphorescent worm,' and describes the creature as about one and a half inches long, worm-like in all respects. My sister is sure it was not an ordinary glow-worm, with which she is perfectly familiar; and, moreover, she called the attention of a cousin to the creature at the time, who corroborates her account. Are there worms in England capable of emitting light besides the glow-worm? If so, are they at all common?"

In reply to a series of questions, I was able to elicit these further particulars:—"It was in a garden in the village of Long Wittenham, near Didcot, on a dark evening in the latter part of September last [1892], or the beginning of October. My sister's attention was attracted by the light on the ground, and she picked the worm up. While she cannot positively assert that she saw it in motion on the ground, it certainly wriggled in her hand. For a few seconds also after putting it down her fingers remained phosphorescent."

The notice of the public, so far as I have been able to ascertain, was first directed to this phenomenon among earthworms by Grimm in 1670, but scientific observation, as we now understand it, was then scarcely known. A century elapsed before any further record was made in the periodicals of Europe which I have consulted, then came a paper by Flaugergues in 1781. This article, which appeared in Lichtenberg's magazine, was written in German. In 1873 Cohn's observations on the same subject were published in the well-known *Zeitschrift für Wissensch. Zool.*, while numerous recent writers have further contributed to our knowledge, especially in relation to the Continental species.

Thus in 1872 an article appeared in the French Annals of Natural Science, by Panceri, entitled "Studies in the Phosphorescence of Marine Animals," in which he states that the luminosity observed in the case of certain (earth) worms is due to a secretion from the girdle, where special glands exist, and that by the evolution of light there was no perceptible raising of the temperature. In this respect, therefore, the earthworm's glow corresponds with that emitted by the firefly, Noctiluca, and glow-worm. One investigator at least has tested the colour and composition of the luminosity by the spectroscope, and says that it is not uni-coloured or monochromatic, but compounded chiefly of the red and violet rays. Other students regard the substance which produces the light as homogeneous.

In 1838 Eversmann published an article on a night-shining worm in Russian, and in 1871 an English naturalist named Breese delivered an address on the earthworm before the West Kent Natural History Society, from a meagre abstract of which we learn that he had spent some years on the subject of annelid luminosity, having studied it historically from the year 1805, when Viviani wrote on the phosphorescence of the sea, down to the date of his own delivery. According to Breese the luminosity exists in the excreted glutinous material with which the outer skin of the animal is covered.

More than one creature has at different times borne the name of the phosphorescent worm. In 1837 Dugès, a French writer, described a species under this name (*Lumbricus phosphoreus*), with a girdle extending from the 13th to the 16th segments, and a somewhat flattened body behind. After the lapse of exactly half a century this curious creature was examined again, and named by Giard Photodrilus, or the luminous worm. It has eight setæ, just as our common species have, but they are separate, and not in couples. There is no gizzard, nor does the lip dovetail into the segment behind. It is a small, transparent, rose-coloured worm, and decidedly phosphorescent.

In 1843 when the British Association met at Cork, specimens of an annelid were exhibited by Dr. Allman, which he had discovered in the bogs of the south of Ireland, and which was the cause of a luminous appearance. When irritated the worm gave out a phosphorescent light, which is said to have been much increased by exposing the creature to the vapour of alcohol. The light was of that peculiar soft greenish hue which is characteristic of the phosphoresence observed in light-giving animals, and familiar to most readers in connection with the glow-worm. Another gentleman was reported to have observed the same peculiarity in some annelids which exist in the bogs of Connaught. I have been unable to find any recent reference to or confirmation of these curious observations. Ten years later Mr. Henry Cox exhibited an earthworm which was phosphorescent at a meeting of the Literary and Philosophical Society of Liverpool, held November 14, 1853.

While few records of a trustworthy nature respecting the observation of luminous worms in Britain are available, a good deal has been done by our Continental fellow-workers. Vejdovsky, who wrote a very valuable work on the various species of an-

nelids in 1884, gives us some results of his personal experience, which I believe have never been placed before the English reader. He says that he had the good fortune once at least to observe an interesting case of phosphoresence in connection with the brandling. It was one warm July night in the year 1881, when he was exploring a dung-heap. Naturalists do not usually work with kid gloves and diamond rings. Presently a spot of soft, bluish-white light appeared, which, however, was changeful and unsteady. Now it would disappear, then return anew and shine forth over a larger space, though never with a brilliant hue. He thereupon removed a portion of the manure from the spot where he had observed the luminosity, and found that the light appeared brighter, and shone for a longer time without disappearing, or before it migrated to another spot. By means of a lantern Vejdovsky was able to secure a large number of specimens of the brandling from the dung-heap, which he placed in a vessel for the purpose of subjecting them to careful observation. To his great surprise he found that his finger soon glowed in the darkness with the phosphorescence, which extended generally over the hand where it came into contact with the worms. It was therefore apparent that the luminosity was the product of a fluid secreted by the cutaneous glands, which had attached itself to the hand of the investigator, and now manifested itself in this curious way.

We have an interesting observation on the same subject by Prof. von Stein, which was published at Leipzig in 1883. One evening in the middle of September the Professor was spending some time with a circle of friends at a parsonage not far from Potsdam, when the conversation turned upon phosphorescence and the phenomena of light. Hereupon one of the younger members of the family—who are usually the keenest and most shrewd observers of Nature, and the best friends of the naturalist—observed that there were fountains in the adjoining gardens, the water from which was frequently observed to be full of light-bearing creatures when it was violently agitated. He regarded the affair at first simply as a hoax, or an attempt to make a fool of him—as people are ever ready to do with a hobby-rider—but ascertained eventually that the luminosity was due to the presence of a species of worm which possessed the property of shining when disturbed. As with Vejdovsky, so with Prof. von Stein, the finger which had come into contact with the worm continued to glow for some time after. What species of worm was under observation is not recorded.

It now becomes a question, What end could be served thereby? The philosopher no sooner learns a new fact than he begins to pry into the secret which lies beneath, and stands to it as cause to effect. We have analogy to guide us. The water worms may be compared with the marine animals which produce phosphorescence, while the brandling may be studied in the light of the glow-worm. It may be objected that as worms have no eyes there can be no advantage in their luminosity. But such an argument would be based on the erroneous assumption that a creature without eyes is incapable of receiving impressions from light. That worms are influenced by light is proved both by their habit of avoiding light, and by the experiments which have been carried out by various students. Darwin remarks that as worms are destitute of eyes he at first thought they were quite insensible to light. He found, however, that "light affects worms by its intensity and by its duration." Hoffmeister states that with the exception of a few individuals worms are extremely sensitive to light, and from my own observations I have been able to demonstrate that there are marked differences in the susceptibility of the different species—some being very much more susceptible than others.

Now it follows that if a number of species of worms lived together in one place, as they usually do in a manure heap, it would be a great advantage for a given species to possess a distinguishing feature, such as that of luminosity, to enable two individuals to discover each other's whereabouts, just as the male glow-worm detects the female by the light emitted from her upturned abdomen. We have, moreover, the fact that certain species of earthworm are characterised by a peculiar odour, which must be of great service in preventing promiscuous copulation and hybridity. Though earthworms are destitute of nasal organs they can detect odours, and though sightless they are affected by light.

Viewed in this light a new field of research is opened up which hitherto has been totally unworked, but which may be hoped to yield remarkable results if diligently, patiently, and intelligently tilled.

It would be an easy thing for any one living in the country, with access to an old manure heap, where the brandling (*Allolobophora fœtida*, Sav.) usually abounds, to ascertain whether such luminosity is of common occurrence, and it would be exceptionally valuable to record the period of the year, the state of the atmosphere, the age of the moon, and other data which would enable the specialist to arrive at a satisfactory conclusion. I shall be glad to receive communications, addressed "The Grove, Idle, Bradford," from observers who may find pleasure in such pursuits.

HILDERIC FRIEND.

Quaternions and the Algebra of Vectors.

IN a recent number of this Journal (p. 151) Mr. McAulay puts certain questions to Mr. Heaviside and to me, relating to a subject of such importance as to justify an answer somewhat at length. I cannot of course speak for Mr. Heaviside, although I suppose that his views are not very different from mine on the most essential points, but even if he shall have already replied before this letter can appear, I shall be glad to add whatever of force may belong to independent testimony.

Mr. McAulay asks: "What is the *first* duty of the physical vector analyst *quà* physical vector analyst?" The answer is not doubtful. It is to present the subject in such a form as to be most easily acquired, and most useful when acquired.

In regard to the slow progress of such methods toward recognition and use by physicists and others, which Mr. McAulay deplores, it does not seem possible to impute it to any want of uniformity of notation. I doubt whether there is any modern branch of mathematics which has been presented for so long a time with a greater uniformity of notation than quaternions.

What, then, is the cause of the fact which Mr. McAulay and all of us deplore? It is not far to seek. We need only a glance at the volumes in which Hamilton set forth his method. No wonder that physicists and others failed to perceive the possibilities of simplicity, perspicuity, and brevity which were contained in a system presented to them in ponderous volumes of 800 pages. Perhaps Hamilton may have intended these volumes as a sort of *thesaurus*, and we should look to his shorter papers for a compact account of his method. But if we turn to his earlier papers on Quaternions in the *Philosophical Magazine*, in which principally he introduced the subject to the notice of his contemporaries, we find them entitled "On Quaternions; or on a New System of Imaginaries in Algebra," and in them we find a great deal about imaginaries, and very little of a vector analysis. To show how slowly the system of vector analysis developed itself in the quaternionic *nidus*, we need only say that the symbols S, V, and ∇ do not appear until two or three years after the discovery of quaternions. In short, it seems to have been only a secondary object with Hamilton to express the geometrical relations of vectors,—secondary in time, and also secondary in this, that it was never allowed to give shape to his work.

But this relates to the past. In regard to the present *status*, I beg leave to quote what Mr. McAulay has said on another occasion (see *Phil. Mag.* June, 1892):—"Quaternions differ in an important respect from other branches of mathematics that are studied by mathematicians after they have in the course of years of hard labour laid the foundation of all their future work. In nearly all cases these branches are very properly so called. They each grow out of a definite spot of the main tree of mathematics, and derive their sustenance from the sap of the trunk as a whole. But not so with quaternions. To let these grow in the brain of a mathematician, he must start from the seed as with the rest of his mathematics regarded as a whole. He cannot graft them on his already flourishing tree, for they will die there. They are independent plants that require separate sowing and the consequent careful tending."

Can we wonder that mathematicians, physicists, astronomers, and geometers feel some doubt as to the value or necessity of something so separate from all other branches of learning? Can that be a natural treatment of the subject which has no relations to any other method, and, as one might suppose from reading some treatises, has only occurred to a single man? Or, at best, is it not discouraging to be told that in order to use the quaternionic method, one must give up the progress which he has already made in the pursuit of his favourite science, and go back to the beginning and start anew on a parallel course?

I believe, however, that if what I have quoted is true of vector methods, it is because there is something fundamentally wrong

in the presentation of the subject. Of course, in some sense and to some extent it is and must be true. Whatever is special, accidental, and individual, will die, as it should; but that which is universal and essential should remain as an organic part of the whole intellectual acquisition. If that which is essential dies with the accidental, it must be because the accidental has been given the prominence which belongs to the essential. For myself, I should preach no such doctrine to those whom I wish to convert to the true faith.

In Italy, they say, all roads lead to Rome. In mechanics, kinematics, astronomy, physics, all study leads to the consideration of certain relations and operations. These are the capital notions; these should have the leading parts in any analysis suited to the subject.

If I wished to attract the student of any of these sciences to an algebra for vectors, I should tell him that the fundamental notions of this algebra were exactly those with which he was daily conversant. I should tell him that a vector algebra is so far from being any one man's production that half a century ago several were already working toward an algebra which should be primarily geometrical and not arithmetical, and that there is a remarkable similarity in the results to which these efforts led (see Proc. A.A.A.S. for 1886, pp. 37, ff.). I should call his attention to the fact that Lagrange and Gauss used the notation $(\alpha\beta\gamma)$ to denote precisely the same as Hamilton by his $S(\alpha\beta\gamma)$, except that Lagrange limited the expression to unit vectors, and Gauss to vectors of which the length is the secant of the latitude, and I should show him that we have only to give up these limitations, and the expression (in connection with the notion of geometrical addition) is endowed with an immense wealth of transformations. I should call his attention to the fact that the notation $[r_1 r_2]$, universal in the theory of orbits, is identical with Hamilton's $V(\rho_1\rho_2)$, except that Hamilton takes the area as a vector, *i.e.* includes the notion of the direction of the normal to the plane of the triangle, and that with this simple modification (and with the notion of geometrical addition of surfaces as well as of lines) this expression becomes closely connected with the first-mentioned, and is not only endowed with a similar capability for transformation, but enriches the first with new capabilities. In fact, I should tell him that the notions which we use in vector analysis are those which he who reads between the lines will meet on every page of the great masters of analysis, or of those who have probed deepest the secrets of nature, the only difference being that the vector analyst, having regard to the weakness of the human intellect, does as the early painters who wrote beneath their pictures "This is a tree," "This is a horse."

I cannot attach quite so much importance as Mr. McAulay to uniformity of notation. That very uniformity, if it existed among those who use a vector analysis, would rather obscure than reveal their connection with the general course of modern thought in mathematics and physics. There are two ways in which we may measure the progress of any reform. The one consists in counting those who have adopted the *shibboleth* of the reformers; the other measure is the degree in which the community is imbued with the essential principles of the reform. I should apply the broader measure to the present case, and do not find it quite so bad as Mr. McAulay does.

Yet the question of notations, although not the vital question, is certainly important, and I assure Mr. McAulay that reluctance to make unnecessary innovations in notation has been a very powerful motive in restraining me from publication. Indeed my pamphlet on "Vector Analysis," which has excited the animadversion of quaternionists, was never formally published, although rather widely distributed, so long as I had copies to distribute, among those who I thought might be interested in the subject. I may say, however, since I am called upon to defend my position, that I have found the notations of that pamphlet more flexible than those generally used. Mr. McAulay, at least, will understand what I mean by this, if I say that some of the relations which he has thought of sufficient importance to express by means of special devices (see Proc. R. S. E., for 1890–91), may be expressed at least as briefly in the notations which I have used, and without special devices. But I should not have been satisfied for the purposes of my pamphlet with any notation which should suggest even to the careless reader any connection with the notion of the quaternion. For I confess that one of my objects was to show that a system of vector analysis does not require any support from the notion of the quaternion, or, I may add, of the imaginary in algebra.

I should hardly dare to express myself with so much freedom, if I could not shelter myself behind an authority which will not be questioned.

I do not see that I have done anything very different from what the eminent mathematician upon whom Hamilton's mantle has fallen has been doing, it would seem, unconsciously. Contrast the system of quaternions, which he has described in his sketch of Hamilton's life and work in the *North British Review* for September, 1866, with the system which he urges upon the attention of physicists in the *Philosophical Magazine* in 1890. In 1866 we have a great deal about imaginaries, and nearly as much about the quaternion. In 1890 we have nothing about imaginaries, and little about the quaternion. Prof. Tait has spoken of the calculus of quaternions as throwing off in the course of years its early Cartesian trammels. I wonder that he does not see how well the progress in which he has led may be described as throwing off the yoke of the quaternion. A characteristic example is seen in the use of the symbol ∇. Hamilton applies this to a vector to form a quaternion, Tait to form a linear vector function. But while breathing a new life into the formulæ of quaternions, Prof. Tait stands stoutly by the letter.

Now I appreciate and admire the generous loyalty toward one whom he regards as his master, which has always led Prof. Tait to minimise the originality of his own work in regard to quaternions, and write as if everything was contained in the ideas which flashed into the mind of Hamilton at the classic Brougham Bridge. But not to speak of other claims of historical justice, we owe duties to our scholars as well as to our teachers, and the world is too large, and the current of modern thought is too broad, to be confined by the *ipse dixit* even of a Hamilton.

J. Willard Gibbs.

Glacial Drift of the Irish Channel.

It seems of interest to record that the eurite or microgranite containing blue amphibole (Riebeckite), the rock noticed by Mr. P. F. Kendall in the drifts of the Isle of Man and Caernarvonshire, occurs abundantly in the form of small pebbles on the shore at Killiney, co. Dublin, doubtless derived from the "glacial gravels" of the coast. I have also found a pebble in the raised beach at Greenore, co. Down.

Mr. Teall's description of the rock of Ailsa Craig (*Mineralogical Magazine*, vol. ix. p. 219) enabled the very characteristic pebbles collected by Mr. Kendall to be referred to that mass as a source, or to formerly existing bosses south of or adjacent to it. As far as I am aware, all the material is in the form of pebbles, often only an inch in diameter. This is hardly likely to be its original condition, if removed by ice from Ailsa Craig, and is only one of many points that indicate a redistribution of our so-called "glacial" beds by subsequent action of rivers or other waters.

Grenville A. J. Cole.

Royal College of Science for Ireland, Dublin, March 12.

THE SACRED NILE.

That Egypt is the gift of the Nile is a remark we owe to the father of history, who referred not only to the fertilising influence of the stream, but to the fact that the presence of the Nile and its phenomena are the conditions upon which the habitability of Egypt altogether depends. That that part of Egyptian archæology and myth which chiefly interests astronomers is also the gift of the Nile is equally true.

The heliacal rising of Sirius and other stars at the time of the commencement of the inundations each year; all the myths which grew out of the various symbols of the stars so used, are so many evidences of the large share the river, with its various water levels at different times, had in the national life. It was, in fact, the true and unique basis of the national life.

In this the Nile had a compeer, or even compeers. What the Nile was to Egypt the Euphrates and Tigris were to a large region of Western Asia, where also we find the annual flood to have been in ancient times a source of fertility over an enormous area which is now

desert, the plains being broken by the remains of the ancient canals.

What more natural than that Euphrates, Tigris and Nile were looked upon as deities; that the Gods of the Nile valley on the one hand, and of the region watered by the Euphrates and Tigris on the other, were gods to swear by; that they were worshipped in order that their benign influences might be secured, and that they had their local shrines and special cults.

The god sacred to the Euphrates and Tigris was called Ea. The god sacred to the Nile was called Hapi.

The name Hapi is the same as that of the bull Apis, the worship of which was attributed to Mena.[1] Certainly Mena, Mini, or Menes, as he is variously called, was fully justified in founding the cult of the river god, for he first among men appears to have had just ideas of irrigation; and I have heard the distinguished officers who have lately been responsible for the irrigation system of to-day speaking with admiration of the ideas and works of Menes.

Whether the Tigris had a Menes in an equally early time is a point on which history is silent; but, according to the accounts of travellers, the Tigris in flood is even more majestic than the Nile, and yet the latter river in flood is a sight to see—a whole fertile plain turned into, as it were, an arm of the sea, with here and there an island, which on inspection turns out to be a village, the mud houses of which too often are undermined by the lapping of the waves in the strong north wind.

There is no doubt that the dates of the rise of these rivers not only influenced the national life but even the religions of the dwellers on their banks. The Euphrates and Tigris rise about the time of the spring equinox—the religion was equinoxial, the temples were directed to the east. The Nile rises at a solstice—the religion was solstical and the solar temples were directed no longer to the east. To the Egyptians the coming of the river to the parched land was as the sunrise chasing the darkness of the night; the sun-god of day conquering the star-gods of night; or again the victorious king of the land slaughtering his enemies.

By no one, perhaps, have the impressions produced by the various phases of the river been so poetically described as by Osburn, a writer of vivid imagination, but it must be added that the facts detailed in his description are not exactly capable of being verified by engineering science. Osburn thus describes the low Nile:

"The Nile has shrunk within its banks until its stream is contracted to half its ordinary dimensions, and its turbid, slimy, stagnant waters scarcely seem to flow in any direction. Broad flats or steep banks of black, sun-baked Nile mud, form both the shores of the river. All beyond them is sand and sterility; for the hamseen, or sand-wind of fifty days' duration, has scarcely yet ceased to blow. The trunks and branches of trees may be seen here and there through the dusty, hazy, burning, atmosphere, but so entirely are their leaves coated with dust, that at a distance they are not distinguishable from the desert sand that surrounds them. It is only by the most painful and laborious operation of watering that any tint approximating to greenness can be preserved at this season even in the pleasure-gardens of the Pacha. The first symptom of the termination of this most terrible season is the rising of the north wind (the Etesian wind of the Greeks), blowing briskly, often fiercely during the whole of the day. The foliage of the groves that cover Lower Egypt is soon disencumbered by it of the dust, and resumes its verdure. The fierce fervours of the sun, then at his highest ascension, are also most seasonably mitigated by the same powerful agency, which prevails for this and the three following months throughout the entire land of Egypt."

Then at last comes the inundation:—

"Perhaps there is not in Nature a more exhilarating sight, or one more strongly exciting to confidence in God, than the rise of the Nile. Day by day and night by night, its turbid tide sweeps onward majestically over the parched sands of the waste, howling wilderness. Almost hourly, as we slowly ascended it before the Etesian wind, we heard the thundering fall of some mud-bank, and saw by the rush of all animated Nature to the spot, that the Nile had overleapt another obstruction, and that its bounding waters were diffusing life and joy through another desert. There are few impressions I ever received upon the remembrance of which I dwell with more pleasure than that of seeing the first burst of the Nile into one of the great channels of its annual overflow. All Nature shouts for joy. The men, the children, the buffaloes, gambol in its refreshing waters, the broad waves sparkle with shoals of fish, and fowl of every wing flutter over them in clouds. Nor is this jubilee of Nature confined to the higher orders of creation. The moment the sand becomes moistened by the approach of the fertilising waters, it is literally alive with insects innumerable. It is impossible to stand by the side of one of these noble streams, to see it every moment sweeping away some obstruction to its majestic course, and widening as it flows, without feeling the heart to expand with love and joy and confidence in the great Author of this annual miracle of mercy."

The effects of the inundation, as Osburn shows in another place, "exhibit themselves in a scene of fertility and beauty such as will scarcely be found in another country at any season of the year. The vivid green of the springing corn, the groves of pomegranate trees ablaze with the rich scarlet of their blossoms, the fresh breeze laden with the perfumes of gardens of roses and orange thickets, every tree and every shrub covered with sweet-scented flowers. These are a few of the natural beauties that welcome the stranger to the land of Ham. There is considerable sameness in them, it is true, for he would observe little variety in the trees and plants, whether he first entered Egypt by the gardens of Alexandria or the plain of Assouan. Yet is it the same everywhere, only because it would be impossible to make any addition to the sweetness of the odours, the brilliancy of the colours, or the exquisite beauty of the many forms of vegetable life, in the midst of which he wanders. It is monotonous, but it is the monotony of Paradise."

"The flood reaches Cairo on a day closely approximating to that of the summer solstice. It attains its greatest height, and begins to decline near the autumnal equinox. By the winter solstice the Nile has again subsided within its banks and resumed its blue colour. Seed-time has occurred in this interval. The year in Egypt divides itself into three seasons—four months of sowing and growth, corresponding nearly with our November, December, January, and February; four months of harvest from March to June; the four months of the inundation completing the cycle."

In order to show how the astronomy of the ancient Egyptians—to deal specially with them—was to a large extent concerned with the annual flood and all that depended upon that flood, and how the first solar year used on this planet, so far as we know, was established, it is important to study the actual facts of the rise somewhat closely, not only for Egypt generally, but for several points in the line some thousand miles in extent, along which in the earliest times cities and shrines were dotted here and there.

Time out of mind the fluctuations in the height of the river have been carefully recorded at different points along the river. In the "Description de l'Egypt" we find a full description of the so-called nilometer at Assuan (First Cataract) which dates from a remote period, perhaps as early as the 5th Dynasty.

In Ebers' delightful book on Egypt space is given to-

[1] Maspero, "Hist. Anc." xi. 10.

the description of the much more modern one located at Rodah.

The nilometer, or "mikyas," on the island of Rodah now visible, is stated to have replaced one which was brought thither from Memphis at some unrecorded date. Makreezee in 1417, according to Ebers, saw the remains of the older nilometer.

The present mikyas is within a covered vault or chamber, the roof being supported on simple wooden pillars. In a quadrangular tank communicating with the river by a canal is an octagon pillar on which the Arabic measurements are inscribed. These consist of the pic (variously called ell or cubit) = 0·54 metre, which is divided into twenty-four kirats, in consequence of the rise of the river bed in relatively recent times, the nilometer is submerged at high Nile to a depth of two cubits.

The rise of the Nile can now be carefully studied, as gauges are distributed along the river. We have the Aswân gauge from 1869, the Armant gauge from 1887, the Suhag gauge from 1889, and the Asyût gauge from 1882. The distances of these gauges from Aswân are as follows:—

	Kilometres
Aswân	0
Armant	200
Suhag	447
Asyût	550
Rodah	941

The Rodah gauge is not to be depended on as the movements of the Barrage regulation destroy its value as a record. The heights of the zeros of these gauges above mean sea level are as follows:—

	Metres.
Aswân	84·158
Armant	69·535
Suhag	56·00
Asyût	53·10
Rodah	13·14

Great vagueness arises in there being no very obvious distinction between the gauge readings reached in summer and that from which the rise is continuous. There are apparently rainfalls in the end of spring of sufficient power to raise the Nile visibly in summer, just as muddy rises have been seen in winter to pass down the valley, leaving a muddy mark on the rocks at Aswân and Manfalût. Independently of the actual gauge-reading of the rise, there are facts about it which strike every beholder. At the commencement of the rise we have the *green water*. This occurs in June, but varies in date as much as the top of the flood varies.

From the fact that modern observations show that the very beginning of the rise, and the first flush, second flush, and final retirement vary, it seems evident that the ancient Egyptians could not have had any fixed zero-gauge or time for the real physical fact of the rise, but must have either deduced from a series of observations a mean period of commencement, or a mean arrival of the red water, or a mean rising up to a certain gauge.

First to deal with the green water. Generally when the rise of an inch or two is reported from the nilometer at Rodah, the waters lose the little of clearness and freshness they still possessed. The green colour is the lustreless hue of brackish water within the tropics, and only the finer class of modern filter can render such water clear. The colour is really due to algæ.

Happily, the continuance of this state of the water seldom exceeds three or four days. The sufferings of those who are compelled to drink it in this state, from vesicary disease, even in this short interval, are very severe. The inhabitants of the cities generally provide against it by Nile-water stored in reservoirs and tanks.

Col. Ross, R.E., noticed in 1887 and in 1890, when, owing to the slow retreat of the Nile, the irrigation officers had to hold back many basins in the Gizah province; and also in 1888, when the water remained long stagnant; that the basin-water got green—showed the algæ and smelt marshy, just as the June green water does.

Hence it has been argued that as the Nile-water in the bed of the stream—even in very slow-flowing back-waters—does not become green, the greenness must be produced by an almost absolute stagnation of the water. We know of great marshes up above Gondokoro, and hence it is thought that the green water of summer, which comes on suddenly, is this marsh-water being pushed out by the new water from behind, and that is why it heralds the rise. No one has so far minutely observed the gradual intrusion of the green water.

The rise of the river proceeds rapidly, and the water gradually becomes more turbid. Ten or twelve days, however, elapse before the development of the last and most extraordinary of all the appearances of the Nile, thus described by Mr. Osborn[1]:—"It was at the end of—to my own sensations—a long and very sultry night, that I raised myself from the sofa upon which I had in vain been endeavouring to sleep, on the deck of a Nile boat that lay becalmed off Benisoueff, a town of Middle Egypt.

"The sun was just showing the upper limb of his disc over the eastern mountains. I was surprised to see that when his rays fell upon the water, a deep ruddy reflection was given back. The depth of the tint increased continually as a larger portion of his light fell upon the water, and before he had entirely cleared the top of the hill it presented the perfect appearance or a river of blood. Suspecting some delusion, I rose up hastily, and looking over the side of the boat saw there the confirmation of my first impression. The entire body of the water was opaque and of a deep red colour, bearing a closer resemblance to blood than to any other natural production to which it could be compared. I now perceived that during the night the river had visibly risen several inches. While I was gazing at this great sight, the Arabs came round me to explain that it was the Red Nile. The redness and opacity of the water, in this extraordinary condition of the river, are subject to constant variations. On some days, when the rise of the river has not exceeded an inch or two, its waters return to a state of semi-transparency, though during the entire period of the high Nile they never lose the deep red tinge which cannot be separated from them. It is not, however, like the green admixture, at all deleterious; the Nile water is never more wholesome or more deliciously refreshing than during the overflow. There are other days when the rise of the river is much more rapid, and then the quantity of mud that is suspended in the water exceeds, in Upper Egypt, that which I have seen in any other river. On more than one occasion I could perceive that it visibly interfered with the flow of the stream. A glassful of it in this state was allowed to remain still for a short time. The upper portion of it was perfectly opaque and the colour of blood. A sediment of black mud occupied about one quarter of the glass. A considerable portion of this is deposited before the river reaches Middle and Lower Egypt. I never observed the Nile water in this condition there, and indeed no consecutive observations exist of the reddening of the water. It is quite clear that the reddening cannot come from the White Nile, but must be the first floods of the Blue Nile and the Atbara coming down."

Rate of Rise of the Nile.—The rate in flood is $1\frac{3}{4}$ days from Wady Halfa to Aswân and six days from Aswân to Rodah (941 kilometres). In very high Niles this is perhaps accelerated to five days. In the early flood rising from, say, one cubit Aswân to six cubits, where there are many dry sandbanks, and the spreading out of the river is considerable, and there is an absence of overlapping

[1] "Monumental Egypt," chapter i.

flushes from behind, the rate goes up to fifteen days. There is a very great difference in time and rate between Green and Red Nile. The rise is 45 ft. at Aswân, 38 at Thebes, and 25 at Cairo.

From the data obtained at the gauges named which have been kindly forwarded to me by Mr. Garstin, the U.S. of State of the Public Works Department of Egypt, I have ascertained that the average time taken by the flood to travel now between Thebes and Memphis is about nine days. Although the river bed is now higher than formerly, the land around Thebes, according to Budge, having been raised about nine feet in the last 1700 years, still the same elevation has taken place at Memphis, so that no difference in the velocity of the stream would be produced by this cause.

The great difficulty experienced in understanding the statements generally made concerning the Nile-rise arises from the fact that the maximum flood is as a rule registered in Cairo upwards of 40 days after the maximum of Aswân.

For the following account of how this is brought about I am indebted to the kindness of Col. Ross, R.E.:—

"The behaviour of the flood at the Aswân gauge is as follows: Between August 20 and 30 a good average gauge of 16 cubits is often reached, and between August 27 and September 3 there is often a drop of about 30 centimetres. The August rise is supposed to be mostly due to the Blue Nile and Atbara River. Between September 1 and 8 the irrigation officers generally look for a maximum flood-gauge of the year at Aswân. This is supposed to be the first flush of the White Nile. In the middle of September there are generally two small flushes, but the last twenty days of September are generally distinctly lower than that of the first week. The final flush of the Nile is seldom later than the 21st to 25th September.

"All this water does not merely go down the Nile; it floods the different basins. The opening of these basins begins from the south to the north. This operation is generally performed between the 29th September and the 22nd October. The great Central Egypt basins are not connected with the Nile for purposes of discharge into the river between Asyût and near Wasta, or a distance of 395–90 kilometres = 305 kil.

"The country in the middle or Central Egypt is broad, and thus there is an enormous quantity of water poured out of these basins into the lower reaches of the river about the 20th October, which seriously raises the Nile at Cairo, and in a good average year will bring the Cairo gauge (at Rodah) up to the maximum of the year on or about October 22, and hence it is that the guide books say the Nile is at its highest in the end of October.

"A gauge of 16½ cubits at Aswân while the basins are being filled does not give more than 21 cubits at Rodah (Cairo), but as the basins with a 16½ gauge will fill by the 10th September, it follows that a 16½ to 16 cubit gauge at Aswân will not give a constant Cairo gauge, as the great mass of water passes by the basins and reaches Cairo. Hence we have frequently the paradox of a steady or falling gauge at Aswân showing a steady rise at Cairo.

"If the gauge at Aswân keeps above 16 cubits to near the end of September, the basin-emptying is much retarded, as the emptying at each successive basin fills the Nile above the 16 cubit level; *hence the lower halves of the chains of basins do not flow off*, and thus when the great Middle Egypt basins are discharged, they do not raise the Nile so much as they do when the last half of September Nile is below 16 at Aswân.

"In years like 1887 and 1892, which differ from each other only in date of maximum gauge at Aswân, the river, having filled the basins in 15 to 20 days instead of in 25 to 30 days, comes down to Cairo in so largely increased a volume that a really dangerous gauge of 25 cubits at Cairo is maintained for over a fortnight (the average October gauge in Cairo is about 23 cubits), and from September 10 to October 25 the river remains from 24 cubits to 25½ cubits, and the Middle Egypt basins discharge so slowly that the opening day is hardly traceable on the Cairo gauge.

"In the 1878 flood, which was the most disastrous flood possible, the river rose in the most abnormal fashion, and on October 3 attained 18 cubits at Aswân. This breached the Delta, and in addition so delayed the Upper Egypt basins emptying from the reason before given that the wheat was sown too late, and got badly scorched by the hot winds of March and April." [1]

J. NORMAN LOCKYER.

THE LANDSLIP AT SANDGATE.

THE causes of landslips are in general so well known and the localities which are liable to them so clearly defined on geological principles that when on Monday, March 6, the public were startled by the news of a landslip at Sandgate, the probability would be that geologists who knew the district would be by no means surprised, more particularly as the locality of the catastrophe is in the midst of a typical section shown in many of the textbooks, and the town itself gives its name to a subdivision of the Cretaceous rocks.

The event, however, does not appear to have been expected, and since it has happened conjectures as to its cause have been numerous; but the true explanation has been wanting.

The series of rocks which, in descending order, form the country about Sandgate are the Folkestone beds, the Sandgate beds, the Hythe beds, and the Atherfield clay. Amongst these it is natural to look in the first instance for the presence of clays, as the probable origin of a landslip, though very loose sands have also been known to give way. The Folkestone beds are for the most part sand and they are bound together by bands of grit. Moreover, they are above the affected area. The Hythe beds are likewise characterised by bands of hard limestone, separated by calcareous sands. There are left the Atherfield clay, whose nature is indicated by its name, and the Sandgate beds.

The most recent description of these is that of W. Topley, F.R.S., in the *Comptes Rendus* of the Congrès Géologique International, 1888, in which they are briefly characterised (p. 257) as "*Argiles vertes et sables.*" The same writer's description of them in 1883 (quoted also by H. B. Woodward in 1887) is somewhat different, but in his "Geology of the Weald," 1875, they are said to consist of dark clayey sand and clay, the total thickness being given as 80 ft. In his more detailed description, however, Mr. F. G. H. Price divides these 80 ft. into four parts, the lowest 20 ft. being all "clayey beds" (Proc. Geol. Assoc., vol. iv. p. 554). In a still earlier account by Prof. Morris (*l.c.* vol. ii. p. 41) we have the following interesting statement:—"The dark-greenish sub-argillaceous sands, known as the Sandgate beds, rise on the shore at a short distance west of Folkestone. The low undercliff which skirts the shore from Folkestone nearly to Hythe owes its origin to the presence of these beds, which from their retention of water and slight coherency of structure have caused the frequent subsidence of the beds above."

It would appear, then, that there are two possible sources of the slipping—the Atherfield clay and the clayey bands of the Sandgate beds, and thus much was indicated at once by Mr. F. W. Rudler (*Daily Graphic*, March 8).

On a personal examination of the area the whole history of the subsidence becomes clear enough. At

[1] The modern Egyptians still hold to the old months for irrigation. 7 Tuba=January 15 is commencement of wheat irrigation; 30 Misra is the last safe date for sowing maize in the Delta; 1st Tut is the date of regulating the bridges=September 8 in Upper Egypt.

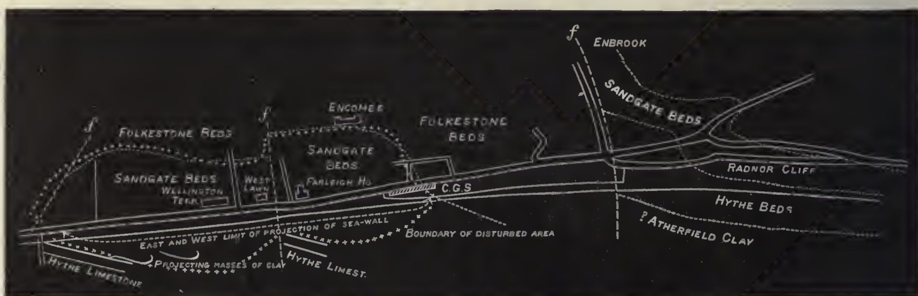
Sandgate itself neither the Atherfield clay nor the Sandgate beds are well exposed, but on the seashore between there and Folkestone we meet with the white-weathering massive limestone of the Hythe beds at Mill Point, and to the west of it. They are here dipping east at a moderate angle, and if this dip is continued, as the beds rise to the west, there would be room for the 60 feet of them which are seen at Hythe, between their probable outcrop in the lower part of the Enbrook Valley and low-water mark, opposite its debouchure. It must be here, if anywhere, that the recorded appearance of Atherfield clay occurs—for the state of things above described must here be terminated by a fault, as will be presently explained, and nowhere else along the coast till Sandgate is entirely passed can this clay occur within 40 yards seaward of low-water. On the east side of Enbrook, however, there is no landslip, and the actual landslip is thus shown to have nothing to do with the Atherfield clay.

Above the strong bands of Hythe limestone, however, west of Mill Point, are seen about 20 feet of soft, crumbling clay, occupying the base of the low cliff and becoming sandier above, as described by Mr. Price, and it is easily seen that the bottom of the Enbrook Valley is excavated in clay. The same clay is admirably seen on the other side of Sandgate, in the first cutting beyond Hythe Station on the branch line from Sandling Junction, so that though it is not now well exposed in Sandgate itself, we may be sure that it forms a continuous band immediately above the Hythe limestone.

Now, continuing to examine the coast below Sandgate on the west side of Enbrook we find an outcrop of Hythe limestone nearly opposite Farleigh House. Here also it has a dip towards the east; but it has also an abnormally high dip—perhaps 10°—inshore; such a dip in itself indicates a dislocation in the neighbourhood, but independently of this, the position of this band at the same level as that at Mill Point, while both bands dip, proves that there is a fault between the two, probably along the Enbrook Valley, with a downthrow on the west. This brings down the clay band at the base of the Sandgate beds to the sea level immediately to the east of the limestone above mentioned, and further on, to the east of the coastguard station, the sandy beds of the Folkestone series, which may, however, have slipped.

Going further west, we find the same band of Hythe limestone exposed on the sloping shore, having a similar easterly dip; but not so great an inshore dip, which, unless this were a lower band of Hythe limestone (which other observations negative), proves a second fault between these two, with a downthrow also to the west, but of smaller amount. Further west again, and just beyond the town, the sandy Folkestone beds are found at a lower level than they should be if the stratification were regular, and in the slight valley intervening there is a spring, which may indicate the line of another fault; or it may be that all this is only a surface slip; but, in any case, Folkestone beds occupy the actual surface.

The strike faults thus indicated are only what we might expect if the strata broke, as they so often do, during their upheaval. It is plain that such faults will rather complicate the surface exposure of the clayey rocks which overlie the Hythe limestone. Now, if we allow some 100 feet for the Sandgate beds, so as to include in the title all that portion of the series above the clay band at the base, which is not strengthened by the occurrence of indurated bands, and draw, from the purely geological considerations detailed above, the boundary of their surface exposure, which will not be an entirely simple one, *it exactly coincides with the boundary of the disturbed area.* Thus the upper boundary commences just beyond the town on the west, and runs very nearly along the line of the most westerly fault, till the latter has Folkestone beds on both sides of it; it then changes direction, and runs parallel to the outcrop of the Hythe beds on the foreshore, sloping down to a point above West Lawn, that is, to the probable position of the second fault; it is then thrown back along the probable line of that fault. It then again changes its direction and runs at first parallel to the second outcrop of the Hythe limestone, afterwards sloping down rapidly to the shore, so as to follow what would be probably the line of outcrop of the first hard band in the possibly slipped mass of the Folkestone beds. The conclusion from this seems inevitable. *The whole disturbance is due to a motion of soft Sandgate beds where they are unprotected by the overlying hard bands of the Folkestone beds.*



The nature of the motion can be determined by an examination of its upper, and particularly of its lower limit. The greatest amount of visible disturbance has taken place along the upper limit; here the ground is seen to have slipped downwards and forwards. This might be caused by the collapse of an underground hollow if such a thing were possible, but the loose sandy and clayey nature of the rocks would not admit of such a hollow being formed, and the thick clay band at the base would effectually shield the Hythe limestones from chemical erosion. The lower limit, however, shows very plainly that the motion has been a simple slip in a south-east or east-south-east direction. In the first place the westerly band of Hythe limestone on the foreshore which abuts against a concrete groin is absolutely unmoved, and the sea-wall above is quite intact (which is a second proof—if, after what has been said above, any further proof were needed, that the Atherfield clay has nothing whatever to do with the matter). In the second place, immediately to the east of this outcrop, the sea-wall has bulged forward by about three feet, as shown by the next, wooden, groin, and near low-water mark the overlying clay is seen

to be bulged up, so as to form a mound on the foreshore, which is being rapidly destroyed by the sea; while further east, opposite the end of Wellington Terrace, the overlying more sandy clays are also seen bulged up. Along the main road also, in front of West Lawn, on the western side of the supposed fault, the surface has been squeezed up. On the eastern side of this fault, further cracks, indicating a forward motion, are seen at the entrance to Encombe grounds; and, finally, the Coast Guard houses and the wall in front bulge forward at least three feet, and probably more, and the two sides of the street opposite have been squeezed together.

Thus the whole disturbance has been caused by the slipping downwards of the overlying soft beds over the inclined plane formed by the basement band of clay which rests on the Hythe limestone as a firm foundation, the direction of motion having been somewhat modified by the resisting mass of rock which lies to the east, and by the natural tendency of the sliding mass to take the shortest course to a lower level.

It is thus seen that the circumstances of the locality exactly fulfil the usual geological conditions for a landslip—*i.e.* a sloping bed of clay, which is liable to become slippery, and whose dip is towards the lower surface level where the overlying rocks find no support. Hence it may safely be said that any geologist, whose attention had been specially directed to the question, could have predicted that such an occurrence was extremely likely, sooner or later, to happen. There is, however, one necessary condition, which does not depend on the lie of the strata and the form of the ground, and that is that the clay should become slippery. This condition will probably account for the fact that in the area to the east of the Enbrook fault where all the other conditions are satisfied, *i.e.* in the neighbourhood of Radnor Cliff, no landslip has occurred. Clay is of course rendered slippery by the access of water. Now water will easily find its way through sandy strata, and there are sandy beds even in the lower portion till we come to the band of clay itself. As this is equally true in both localities the only difference can be in the amount of water.

Now there is a natural tendency for water to run down the dip slope of the strata, especially when there are hard bands as in the Folkestone beds, so that in this case most of the water will come from the west, and this source is cut off from the Radnor Cliff side by the Enbrook Valley, to the east of which there is little or no gathering ground; but to the west and north-west of the disturbed area there is a wide expanse of high ground, mostly rising 100 feet above the level of the Sandgate beds, and the water which falls on this finds its easiest outlet into these beds. They are therefore exactly in a position to get waterlogged, and that they are so is shown by the numerous springs that may be seen along the upper limit of the disturbed area.

The above considerations show that this area always has been and always will be liable to landslips. The lie of the beds which produces this liability cannot be altered by human agency, but the liability may be reduced to a minimum by a suitable system of drainage, which shall prevent the access of so large a body of water to so dangerous an area.

In the meantime the inhabitants of Sandgate may congratulate themselves that the shoreward dip of the beds and fault which breaks their continuity have reduced the result of the slip to a minimum, and rendered possible the remarkable circumstance that, though it happened in an area covered with houses, not a single house has been actually thrown down—not a single life lost.

As to the *immediate* cause of the occurrence, it is perhaps scarcely necessary to look for it. The landslip must necessarily have occurred at some time or another, and the conditions must for a long time have been gradually accumulating, by the constant access of water and the wearing action of the sea. If, however, the free discharge of the water from the beds has been in any way interfered with—by the stoppage of wells, or the construction of imperforate sea-walls—this would doubtless tend to the acceleration of the catastrophe; and an exceptionally wet season, like that we have recently experienced, might suffice to determine it. It would be scarcely necessary to add, except that the idea has been mentioned in the House, that the blowing up of the *Benvenue* and the *Calypso* could have absolutely nothing to do with it: in the first place, because the scene of the explosions was to the west of the disturbed area, and cut off from it by the massive Hythe beds, which are absolutely undisturbed—to say nothing of the Atherfield clay at sea which must necessarily intervene; secondly, because such a cause could not require several months to operate; and, lastly, because a vibration would rather tend to cause such beds to settle than to slip.

J. F. BLAKE.

NOTES.

PROF. VIRCHOW will deliver the Croonian Lecture this afternoon, and in the evening he will be entertained at the public dinner which is to be given in his honour at the Hôtel Métropole. It may at the same time be noted that an important scientific work, in three volumes, has just been issued by the Berlin publisher, August Hirschwald, in memory of the celebration of Prof. Virchow's seventieth birthday. The work is entitled "Internationale Beiträge zur Wissenschaftlichen Medicin," and among the contributors to it are Sir James Paget, Sir Joseph Lister, and other English writers.

A MOVEMENT has been started for the celebration of the hundredth anniversary of the birth of the illustrious Russian mathematician, Lobatcheffsky, who was described by the late Prof. Clifford as "the Copernicus of geometry." He was born on October 10, 1793. It is proposed that honour shall be done to his memory at the Imperial University of Kasan, with which he was for many years connected as a professor and as rector. The Physico-Mathematical Society of the University, which has taken the matter in hand, hopes to be able either to establish a prize with Lobatcheffsky's name for researches in mathematics, or to erect a bust of the great investigator in the University buildings. If the funds suffice, both of these things will be done. Subscriptions should be sent to the Physico-Mathematical Society, Kasan.

THE German Congress of Naturalists and Physicians, which was postponed last year on account of the outbreak of cholera, is to meet this year at Nürnberg.

PROF. W. C. ROBERTS-AUSTEN, F.R.S., chemist and assayer to the Royal Mint, and Mr. Thomas Bryant, President of the Royal College of Surgeons, have been elected members of the Athenæum Club, under the provisions of the rule by which the Committee is empowered to elect annually nine persons "of distinguished eminence in science, literature, the arts, or for public services."

THE half-yearly general meeting of the Scottish Meteorological Society was held at Edinburgh on Monday, March 13. The council of the society submitted its report, and the following papers were read:—On the temperatures of Lochs Lochy and Ness as affected by the wind, by Dr. Murray; mean temperature of London from 1763 to 1892, by Dr. Buchan; hygrometric researches at the Ben Nevis Observatories, by A. J. Herbertson.

WE understand that an enormous iron meteorite weighing nearly one ton (2044 lbs.) has just been received by Mr. J. R.

Gregory, of Charlotte Street, Fitzroy Square, from the same locality as the one described by him in NATURE in November last; it is 4 feet 2 inches long by 2 feet 3 inches wide and 20 inches thick. It comes from Youndegin in Western Australia.

THE secretary of the Physical Society asks us to say that in the report of the Society's annual general meeting (NATURE, March 2, p. 429) the name of Mr. J. T. Hurst was wrongly included in the list of members lost by death.

ATTENTION is called in the North Atlantic Pilot Chart to the fact that the great astronomical event of the month of April—the eclipse of the sun on April 16—will have certain features of special interest to the science of marine meteorology. Masters of vessels and observers who may be within the limits of the visibility of this eclipse are earnestly requested to make reports of their observations. The chart shows graphically the path of the total eclipse, the northern limit of visibility, and curves showing at what places the eclipse begins at 1 hour, 2 hours, and 3 hours, and when it ends at 3 hours, 4 hours, and 5 hours, Greenwich mean time, April 16. It is pointed out that there are observations which any one can make, and that these may prove to be of great interest and value. The following are particularly desired: (1) any changes in the clouds accompanying changes of temperature during the eclipse; (2) reading of the barometer every half hour from 11.30 to 5.30 G.M.T., while in the path of total eclipse; (3) temperature of the air, both wet and dry bulb, during the same interval; (4) any peculiar appearance of light during the eclipse; (5) the altitude and azimuth of any faint comet that may be detected during the eclipse.

THE weather during the latter part of last week was exceptionally fine over England, the daily maxima being frequently above 60°, and reaching 66° in the midland counties on Sunday, a temperature which is nearly 20° above the mean maximum for the time of year. The nights, however, were very cold, owing to the radiation under a clear sky; in some localities the readings on the grass were as low as 23° to 25°, and little, if any, above freezing in the shade. These conditions were occasioned by the distribution of atmospheric pressure, there being a well-defined anticyclone over the southern parts of England and over part of the continent. But in Scotland and Ireland the weather was much less settled; low-pressure areas lay off the north of Scotland, causing gales and occasional rainfall, while hail occurred at Wick on Friday. At the beginning of the present week the barometer fell decidedly, the anticyclone moved to the eastward, and the type of weather underwent a complete change, fog becoming prevalent at many places in the southern parts of the kingdom, and on Tuesday a new depression reached the north of Scotland, accompanied by rainy and unsettled weather generally. The official report for the week ending the 11th instant showed that bright sunshine was more prevalent than it has been for many weeks, and that it exceeded the average amount in all districts; also that there was a great deficiency in the amount of rainfall in all districts, except in the north of Scotland.

Das Wetter for February contains some particulars respecting the extraordinarily high barometer readings during January. At the commencement of that month the isobar between Lapland and Finland indicated the unusual height of 30·9 inches, which increased to 31·1 on the 3rd. On this day the centre of high pressure was in the vicinity of the White Sea, the reading at Archangel being 31·2 inches, and at Kargopol, on the Onega, 31·3 inches. Such high readings in those parts in winter are the more noteworthy, owing to the frequent passage of depressions over the north of Europe during that season. Subsequently the high pressure area shifted to Eastern Siberia, where high readings are more usual. On January 12 the pressure at Irkutsk exceeded 31·5 inches, and on the next day it reached 31·7. According to Dr. Hann, such a high reading had only been recorded once before, viz. on December 16, 1877, at Semipalatinsk. But on the morning of January 14, the reading at Irkutsk, reduced to sea level and corrected for gravity, attained the unprecedented height of 31·8 inches. So far as it is known this is the highest reading that has ever been recorded on the globe. These high pressures were also accompanied by very low temperatures. On January 14 the thermometer at Irkutsk fell to minus 51°·3, or about 40° below the mean for the time of year. In the north of Sweden the thermometer fell to minus 76°, or 38° below the freezing point of mercury.

SOME shocks of earthquake have lately been felt at Quetta. Two occurred on February 13 at 9.50 p.m., and another shock on the 14th at about 3 a.m. These shocks caused a considerable scare, and many people rushed out of doors, the condition of many houses in Quetta being anything but safe. The *Pioneer Mail* says that several houses have since fallen at Quetta, and a number of people have been injured, and two killed thereby.

DR. D. D. CUNNINGHAM is carrying on a series of microscopical investigations into the Indian potato blight. Elaborate experiments are also being made in the practical treatment of the crop and of diseased soils. The results, according to the *Pioneer Mail*, are expected to be important, and will be made public in due course.

IT appears from the Ceylon Census Report for 1891 that the bulk of the population of the island live by agriculture. The proportion of the agricultural class to the general population is in Ceylon 70·5; in India 64·09; in England and Wales 15·44. Next in order of number comes the industrial class, which includes something less than one-sixth, and after it the commercial class, holding one-twentieth. The *Ceylon Observer* notes as remarkable the fact that in the Southern Province there is a larger Sinhalese industrial population than in any other province—a result, it is supposed, attributable to the large number of people engaged in utilising the products of the cocoa-nut tree, with a certain number of workers in jewellery, tortoise-shell, &c.

TWO Akka girls, who were rescued from Arab capturers by Dr. Stuhlmann and his companions, have been brought to Europe, and will remain in Germany for some months. In the summer they will be taken back to Africa, where they will be placed in some mission house, or otherwise provided for. They are supposed to be between seventeen and twenty years of age. A correspondent of the *Daily News*, who saw them at Naples, says they are well proportioned, and as tall as a boy of eight years of age. Their behaviour is "infantile, wild, and shy, but without timidity." One of them was always cross, bending her head, and glaring from beneath frowning brows; while the other often laughed joyously, was pleased with bead bracelets and other trinkets given to her, and expressed by a queer sniff of her flat nose her appreciation of some chocolate bonbons. After making "a capital dinner on rice and meat," they greatly enjoyed the sunshine in a pretty garden, where they gradually grew more confident, and finally allowed themselves to be photographed arm-in-arm with the little son of their hostess. "The coquettish one shook with laughter, and seemed to guess that a process was going on flattering to her vanity, while the cross one still looked gloomy and suspicious. They showed neither wonder nor admiration of the people and things around them in the artistically furnished house and tasteful garden; their eyes, though large and lustrous, have less expression than the ugly eyes of a monkey." These interesting representatives of one of the pygmy races of the world are to be presented to various scientific societies in Berlin.

AN interesting address delivered by M. Paul Richer at the last meeting of the French Association for the Advancement of Science is printed in the current number of the *Revue Scientifique*. The subject is the relation of anatomy to art. M. Richer gives a lucid account of the canons of the human figure which have been adopted during various periods in the history of art, referring especially to those of the Greek sculptors Polycleitos and Lysippos and to those of Leonardo da Vinci, Albert Dürer, and Jean Cousin. He then shows that we now have materials for the establishment of a scientific type of the proportions of the human body, so far at least as the white race is concerned. This type is not, of course, to be reproduced in the works of artists; but M. Richer thinks it may be of real service to them as a guide in the appreciation of the proportions of the different models they have from time to time to study.

MR. A. C. MACDONALD contributes to the *Agricultural Journal* of Cape Colony a full and interesting account of what has been done to develop the dairy industry in Great Britain. Speaking of the same industry in Cape Colony, he says that it is there only in its infancy. This is largely due to the difficulty which farmers otherwise favourably circumstanced have had hitherto to contend with in the transport of their dairy products to market in good condition. Now, however, the extension and union of railways have more or less removed this difficulty, and many of the leading farmers, taking advantage of the facilities afforded by such extension and union, have greatly increased their butter production. In fact, within the last two years the increase in the manufacture of this commodity in the colony has been very large. Mr. Macdonald sees no reason why in districts such as Alexandria, Bathurst, Peddie, Victoria East, Fort Beaufort, Albany, Port Elizabeth, Uitenhage, and East London, where it has now become difficult to farm with small stock or grow grain profitably, dairying should not prove as great a success as it has done in the Australian colonies, which in some respects are not so favourably situated as Cape Colony, provided that the same means are used.

THE nucleus of a palæontological collection was formed at the Johns Hopkins University five years ago by Dr. W. B. Clark from the deposits of the Atlantic coastal plain. He was able to gather together a very large amount of material owing to the richness of the formations in fossils and their accessibility to the city of Baltimore; and since that time additions have been made each year by collection and by exchange with the National and State Surveys and educational institutions. We learn from the new number of the University's "Circulars" that there was a greater increase of the fossil collections during the past year than during any preceding one. This was accomplished mainly by exchange and purchase, although a considerable amount of material was collected in the field. Among the more notable additions was a collection sent in exchange by Mr. G. F. Harris, of the British Museum. This collection is very rich in tertiary fossils, illustrating many of the typical English localities. It contains hundreds of species from the Eocene, Oligocene, and Pliocene of England. Owing to the fact that the richest and finest collections of the Palæontological Museum of the University are from the American tertiary, these English tertiary fossils are said to be of the highest interest and usefulness to students of geology.

AN interesting paper on Artesian wells as a water supply for Philadelphia was lately read by Prof. O. C. S. Carter before the chemical section of the Franklin Institute. A long-continued drought caused much inconvenience at Philadelphia during the summer of 1892, so that the inhabitants would be likely to welcome any practicable suggestion for providing them with new supplies of fresh and wholesome water. Prof. Carter, after careful investigation, strongly recommends the use of artesian wells, the water of which, he says, would be of considerable quantity and excellent quality.

AN instrument for measuring densities of liquids, which for simplicity can hardly be surpassed, is described by A. Handl in the *Wiener Berichte*. It consists of two glass tubes joined by an indiarubber tube. One of them is 30 cm. long and about 1 cm. wide, and bears two marks scratched into the glass at a distance of 20 cm. This tube is immersed in the liquid to be examined up to the lower mark. Meanwhile the other tube is totally immersed in water. On pulling it out the liquids in both tubes rise until that in the first tube reaches the second mark. The height of the water-column, read off on a suitable scale, measures the density of the liquid.

MESSRS. SIMPKIN, MARSHALL AND CO have issued Miss Eleanor A. Ormerod's "Report of Observations of Injurious Insects and Common Farm Pests, during the Year 1892, with Methods of Prevention and Remedy." This is Miss Ormerod's sixteenth report. She notes that during 1892 most of the insect infestations commonly injurious to field crops and fruit were present to such an extent as to cause inquiry as to their nature and as to methods of prevention, but that for the most part they did not affect large districts to a serious extent.

A NEW scientific journal devoted to the interests of general systematic botany has made its appearance, published at Chambésy, near Geneva, under the title *Bulletin de l'Herbier Boissier*.

A BOTANICAL DICTIONARY, by Mr. A. A. Crozier, has just been published by Holt and Co., of New York, containing definitions of over 5000 words.

MESSRS. PERKEN, SON, AND RAYMENT have issued an illustrated catalogue of photographic apparatus, magic lanterns, and optical instruments.

MESSRS. WHITTAKER AND CO. will issue in their Specialists' Series a work on "The Dynamo," by C. C. Hawkins and F. Wallis, and a new edition of Sir David Salomons' work on "The Management of Accumulators." They have also in preparation in the Library of Popular Science an introductory work on "Electricity and Magnetism," by S. Bottone, and one on "Geology," by A. J. Jukes-Browne. Mr. Perren Maycock has completed the second part of his work on "Electric Lighting and Power Distribution," and it will be issued in a few days. An illustrated work on "British Locomotives," by C. J. Bowen Cooke, of the London and North-Western Railway, is in the press, and will probably be issued in May. Messrs. Whittaker have also in the press a new work by J. Horner ("A Foreman Pattern-Maker"), entitled "The Principles of Fitting," and the second part of Mr. Brodie's "Dissections Illustrated."

MESSRS. GRIFFIN AND CO. announce "A Manual of Dyeing," by Dr. Knecht, Mr. Chr. Rawson, and Dr. R. Loewenthal; "Oils, Fats, Waxes, and Allied Materials, and the Manufacture therefrom of Candles, Soaps and other Products," by Dr. C. R. Alder Wright; "Painters' Colours, Oils, and Varnishes, by Mr. Geo. H. Hurst; "Griffin's Electrical Price-Book," edited by Mr. H. J. Dowsing; the tenth annual issue of the "Year-Book of Learned and Scientific Societies;" "A Treatise on Ruptures," by Mr. J. F. C. Macready; "Forensic Medicine and Toxicology," by Prof. Dixon Mann; "The Medical Diseases of Children," by Mr. Bryan Donkin; "A Medical Handbook for the Use of Students," by Mr. R. S. Aitchison; "The Physiologist's Note-Book," by Dr. W. Hill; and "A Text-Book of Biology," by Prof. J. R. Ainsworth Davis.

MESSRS. L. REEVE AND CO. have in preparation a new work on the British Aculeate Hymenoptera from the pen of Mr.

Edward Saunders, uniform with the same author's work on the Hemiptera Heteroptera, just completed.

THE extreme difficulty which is experienced in the separate identification of the typhoid bacillus and the *B. coli communis* in consequence not only of their great resemblance microscopically, but also in the appearances to which they give rise when grown in artificial culture media, has caused much doubt to be cast upon the alleged detection of the former in water. It is well known that the *B. coli communis* is an almost constant attendant upon the typhoid bacillus, being normally present in the alimentary canal, and being, moreover, frequently found in large numbers in polluted streams and contaminated well-water. In nearly all cases, therefore, where a water is suspected of harbouring the typhoid bacillus the *B. coli communis* may also be expected to be present. Unfortunately, the many methods which have been devised, some of which are extremely ingenious, for separating out the typhoid bacillus from other organisms, are based upon the idea that few, if any, micro-organisms can flourish in as acid a medium as this bacillus, and no account has been taken of the refractory nature in this respect of the *B. coli communis.* This organism is, in fact, possessed of far greater powers of resistance than its more dangerous companion, and whilst the proportion of citric acid or phenol to be added, whether directly to the water or to the culture medium, is such that in some cases the other organisms present are destroyed whilst the typhoid bacillus and the *B. coli communis* are left untouched; in other methods the amount of acid prescribed is sufficient to entirely obliterate the typhoid bacillus, leaving, however, the *B. coli communis* sole master of the field. In an extremely interesting paper which has appeared in the *Zeitschrift für Hygiene*, vol. xii. p. 491, 1892 ("Ueber den Typhusbacillus und den *Bacillus coli communis*"), Dunbar discusses very fully all these points, and gives an account of the principal methods in vogue for the isolation of the typhoid bacillus, together with a critical commentary based upon his own experimental observations, as well as those of other investigators. As a result of these researches Dunbar maintains that no absolutely trustworthy method at present exists for the successful identification of the typhoid bacillus in the presence of the *B. coli communis*, and that it is highly probable that the latter has in many cases been mistaken for the former in water supposed to contain the typhoid bacillus. There can be no doubt, however, that, with a knowledge of these imperfections, the judicious application of some of these methods may very greatly facilitate the isolation of the typhoid bacillus in the presence of other organisms, and that, moreover, a method which is able to restrict the varieties present on any given gelatine plate to the *B. coli communis* and the typhoid bacillus already removes some of the chief obstacles.

A FURTHER communication from M. Moissan concerning the chemical properties of the diamond is contributed to the current number of the *Comptes Rendus*. In the first place precise determinations have been carried out of the temperatures at which various kinds of diamonds undergo combustion in pure oxygen. As the action of oxygen upon the diamond has so long been known, it appears somewhat singular that, as M. Moissan states, no exact data concerning the temperature of combustion should hitherto have been obtained. It will doubtless be remembered that Dumas and Stas, in their celebrated experiments in connection with their determination of the atomic weight of carbon, burnt diamonds in a current of oxygen in a porcelain tube heated in an ordinary earthenware table furnace. Other chemists have since performed similar experiments with the aid of the combustion furnaces employed in organic analysis. In order to be able to determine the temperature of such combustion with precision, M. Moissan has employed a modification of Le Chatelier's thermo-electric apparatus, placed along with the diamond in a wide porcelain tube closed at the ends with glass plates through which the combustion in oxygen could be viewed. It was found that when the temperature is slowly raised under these conditions the combustion proceeds gradually without the production of light. But if the temperature is raised 40° or 50° above the point at which this slow combustion commences, a sudden incandescence occurs, and the diamond becomes surrounded by a brilliant flame. Various deeply-coloured specimens of diamonds burnt with production of incandescence and flame at temperatures of 690°–720°, but transparent Brazilian diamonds did not attain the stage of slow combustion without incandescence till the temperature of 760°–770° was reached. A Cape diamond suffered gradual combustion at 780°–790°. Specimens of exceedingly hard boort likewise commenced to combine with oxygen at 790°, and burnt brilliantly at 840°–875°. When Cape diamonds were heated in a current of hydrogen to a temperature of 1200° they remained unchanged; but if the stones had previously been cut they frequently lost their brilliance and transparency. Dry chlorine gas was found incapable of reacting with the diamond until a temperature of 1100°–1200° was attained. Hydrofluoric acid vapour likewise only reacted at about the same high temperature. Vapour of sulphur also requires to be heated to 1000° before reacting, but in the case of black diamonds bisulphide of carbon is produced at about 900°. Metallic iron, at its melting point, combines with the diamond in a most energetic manner, and it is a point of considerable interest that crystals of graphite are deposited as the fused mass cools; hence the experiment forms a striking mode of converting the allotropic form of carbon which crystallises in the cubic system into that which crystallises in the hexagonal system. Melted platinum likewise combines with the diamond with great energy. A most curious reaction has been observed to occur between the diamond and the carbonates of potassium and sodium. When a diamond is placed in the fused carbonate contained in a platinum dish it rapidly disappears, and carbonic oxide is copiously evolved. Fused nitre or potassium chlorate, however, have not been observed to exert any action upon diamonds.

NOTES from the Marine Biological Station, Plymouth:—Recent captures include examples of the Hydroid *Myriothela phrygia*, the Opisthobranchs *Aplysia punctata* and *Oscanius membranaceus*, and the "cotton-spinner" (*Holothuria nigra*). The week has been marked by a rapid increase in the numbers of Echinoderm larvæ, especially of *Auricularia* and *Bipinnaria*, but *Plutei* are still relatively scarce. Ephyræ of *Aurelia* continue plentiful, and have grown appreciably. Among the Anthomedusæ, *Rathkea octopunctata*, *Sarsia prolifera* (without buds), and the gonozooid of *Podocoryne carnea* have been noticed; among Leptomedusæ, the *Eucopium-* and *Eucope-*stages of *Clytia Johnstoni* have made their appearance, together with *Thaumantias Forbesii* (Haeckel) and small *Obelia* medusæ. Several *Muggiæa* and a single *Pilidium* were seen on the 11th inst. The Nemertine *Amphiporus lactifloreus*, and the Anomoura *Eupagurus Prideauxii*, *Galathea dispersa* and *intermedia* have begun to breed.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*, ♂) from India, presented by Mr. G. J. Sheppard; a Leopard (*Felis pardus*) from Kismaya, East Africa, presented by Mr. J. Ross Todd; a Spotted Ichneumon (*Herpestes nepalensis*) from Nepal, presented by Lieut. Philip Egerton, R.N.; six Vulturine Guinea Fowls (*Numida vulturina*) from East Africa, presented by Mr. R. J. Macallister; a Black Tanager (*Tachyphonus melaleucus*) from South America, presented by Miss Trelawny; a Greater Sulphur-crested Cockatoo (*Cacatua*

galerita) from Australia, presented by Miss Amy M. Dundas; three white-tailed Gnus (*Connochætes gnu*, ♂ ♀ ♀) from South Africa, deposited; a Burchell's Zebra (*Equus burchelli*, ♀), two Silver-backed Foxes (*Canis chama*), a Cape Bucephalus (*Bucephalus capensis*) from South Africa, a Salvin's Amazon (*Chrysotis salvini*) from South America, purchased; four Upland Geese (*Bernicla magellanica*) from the Falkland Islands, received in exchange; four Coypus (*Myopotamus coypus*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET HOLMES (1892 III.).—This comet has now become rather a difficult object, but the following ephemeris may be useful for those employing large instruments:—

12h. Paris Mean Time.

1893.	R.A. (app.) h. m. s	Decl. (app.) ° ′ ″
March 16	2 55 29·0	+ 35 27 53
17	57 16·1	30 43
18	2 59 3·5	33 33
19	3 0 51·1	36 23
20	2 38·9	39 13
21	4 27·0	42 2
22	6 15·3	44 51
23	3 8 3·8	35 47 40

THE SIZES OF JUPITER'S SATELLITES.—M. J. J. Landerer describes in the *Comptes Rendus* some experiments made to test the accuracy attainable in measuring the diameters of satellites by their shadows cast on the primary. He took a finely-ground glass plate and blackened it, leaving a space in the middle representing the appearance of Jupiter with its bands and small black spots representing shadows. He then placed it at a distance of 314 m., illuminated it by a suitable light from behind, and sketched the disc through the telescope used for the actual observations. With some practice it was found possible to draw such spots correctly to within one-tenth per cent. M. Landerer then applied his method to the satellites themselves, and found the following numbers for their radii:—0·0199, 0·0184, 0·0435, and 0·0419. The number of observations was twenty-six for the first satellite, seventeen for the second, thirty for the third, and twenty-two for the fourth. The commonly accepted numbers, obtained by micrometric measurements of the bright satellites, are 0·0291, 0·0259, 0·0431, and 0·0367.

OBSERVATIONS OF THE ZODIACAL LIGHT.—In No. 3155 of the *Astronomischen Nachrichten* Mr. Arthur Searle gives an account of the experimental work he and Prof. Bailey have been carrying on with respect to the best methods of making and recording observations of the zodiacal light. Owing to the prevalent use of electric light in the neighbourhood of Harvard College Observatory, the observations were made at some distance away. The general mode of defining the position of the zodiacal light up to the present has been by drawing its outline on a star atlas exactly as it appeared in the sky at the time of observation. The great drawback about this method is that in the majority of cases the zodiacal light has no definite outline, but gradually decreases in brightness as one recedes from the axis of the figure, eventually fading imperceptibly away. That this is so is the general idea and is backed up by observations, but it is also true that the contour, so to speak, of the luminous figure is sometimes sharper at some places than at others. Instead of outline drawings these observers have substituted contour lines in which the degree of light represented by each contour is stated; the latter is accomplished by selecting a portion of the sky "unaffected by the zodiacal light, but of equal brightness with those portions traversed by the contour line." This region would naturally lie near the Milky Way and its situation is defined by the stars in the vicinity. To complete the record the geographical position of the observer's station and the time of observation should be included in the statement. In addition to the contour lines two other suggestions are put forward, (1) that the axis of brightness should be indicated by a line, and (2) that should there be distinctly observed by any chance two cones of light, an outer and an inner, such a distinction should be shown in the record by drawing a boundary between them.

WEINEK'S LUNAR ENLARGEMENTS.—Since the appearance of the magnificent enlargements obtained by Dr. Weinek from the Lick Observatory negatives, many details of surface structure have been brought to light which have up till now evaded even the aided eye. These details, consisting as they do of winding rills, valleys, and hair-like markings, appear quite sharp and distinct in contrast with the larger surface features, and it is this fact that has caused some uncertainty about their being actual features on the lunar surface. Every one acquainted a little with photography knows that a photograph loses in sharpness the more it is enlarged, and it is here very curious to find a picture after being twenty times enlarged with minute details quite crisp and sharp, and the larger portions quite fluffy, as is the case in the enlargement of Vendelinus, taken on August 31, 1890. As Mr. Elger remarks (*Observatory*, March), "if these curious markings represent actual features on the moon's surface, ought they not to be easily seen in any good telescope that shows the formation and its principal details with far greater sharpness than the twenty-times enlarged negative, and many small craters, &c., in addition which are scarcely traceable upon it? One does not understand why this should not be so, unless these objects make an impression on the sensitive plate that they fail to do on the retina, which is hardly likely to be the case." M. Faye, in *Comptes Rendus* (No. 9) for March, when referring to these enlargements, says that several members, MM. Fizeau, Mascart, and Cornu included, reserved their opinions on the interpretation of these markings, which seemed to be the results of retouching. "Certain vermiculées appearances," says he, "show a clearness which is strictly in contradiction with the very general 'estompée' appearance of the lunar cliché."

"L'ASTRONOMIE" FOR MARCH—The March number of this magazine commences with some observations of Jupiter made at the observatories in Juvisy, Bruxelles, and in Spain during the past year. The numerous drawings which accompany the observations impress one with the incessant change that is taking place in the dense atmosphere, while the large red spot was as usual seen ploughing its way apparently through one of the dark belts. The period of rotation of this spot seems to have suffered a retardation during the last twelve months, as will be seen from the following table, which we take the liberty of producing here:—

	h. m. s.		h. m. s.
1879 ...	9 55 35·7	1886 ...	9 55 40·1
80 ...	35·0	87 ...	40·1
81 ...	36·1	88 ...	40·2
82 ...	37·2	89 ...	40·3
83 ...	38·1	90 ...	41·5
84 ...	39·2	91 ...	42·2
85 ...	40·1	92 ...	39·3

M. Guillaume, of the Lyons Observatory, contributes some interesting notes on the appearances of Saturn's rings during the same year, at which time it will be remembered we were lying nearly in its plane. Besides the drawings showing the general features of the planet, there are some illustrating the different degrees of luminosity observed at various parts of the ring itself. "The Circulation of Winds at the Surface of the Globe" is the title of an article by M. A. Duponchel, in which he gives as an introduction a brief historical account of the early hypotheses; while M. Flammarion gives us the fifth chapter on "Comment Arrivera la fin du Monde," dwelling for the most part on the destructive forces at work on the earth's surface.

BERMERSIDE OBSERVATORY.—In the advertising sheets of the *Observatory* for March we are sorry to see the following notice:—"On sale (the owner giving up astronomical work) the 3-foot Common reflector, with or without dome, complete, in perfect order. Mirror by Sir H. Grubb. Full particulars on application to J. Gledhill, Bermerside Observatory, Halifax."

GEOGRAPHICAL NOTES.

A TELEGRAM from Port Stanley announces the return of the Dundee whaling ships to the Falkland Islands (see NATURE, p. 282) on their way home. In the two months during which they were absent it is improbable that high latitudes were reached, but it is evident that a cargo was rapidly obtained, although it is not reported whether the species of whale hoped for was found.

THE Geographical Studentship at Oxford lately held by Mr. Grundy has been awarded to Mr. W. H. Cozens-Hardy, New

College. Mr. Cozens-Hardy has already made some interesting journeys in Montenegro and the neighbouring little-known parts of the west coast of the Balkan Peninsula which he intends to study further.

THE expedition of M. Delcommune by Lake Tanganyika appears to have been the most successful of all those sent out by the Katanga Company, as its leader has returned to Leopoldville, and will soon reach Europe to recount his experiences. The expeditions of Captain Stairs and Captain Bia, although successful in reaching their destination, were unfortunate in losing their leaders, and all the parties suffered terribly from sickness and famine. One of the interesting circumstances of these expeditions is the fact that a bronze tablet commemorating the death of Livingstone has been fixed to the tree at Old Chitambo's, where the great traveller died. This tablet was sent out in duplicate by Mr. A. L. Bruce of Edinburgh, son-in-law of Dr. Livingstone, through Mr. Arnot, who being unable to reach Chitambo's himself, entrusted one of the tablets to Captain Bia, by whose party it was placed in position.

MR. MACKINDER'S educational lectures, of which the eighth was delivered in the hall of the University of London on Friday night, continue to be well attended. The subject of the lecture was the Alps as a factor in European history, and the series of fine maps specially prepared for projection by the lantern enabled the development of the historical argument to be followed from point to point.

THE March number of the *Scottish Geographical Magazine* contains a valuable note by Prof. Mohn on the climate of Greenland, in which he epitomises his discussion of Dr. Nansen's results, published in a recent Ergänzungsheft of *Petermann's Mitteilungen*, and corrects it by the record of Peary's work. The isotherms (reduced to sea-level) run parallel to the coast, the interior being coldest at all seasons; 30° F. compared with 26° on the coast for January, 30° as compared with 50° for July, and on the average for the year the centre of the land is probably about −10°, while the coast has the temperature of 30°.

THE CHATHAM ISLANDS AND AN ANTARCTIC CONTINENT.

AT the last meeting of the Royal Geographical Society Mr. H. O. Forbes discussed the question of the former extension of an Antarctic continent in relation to certain observations made during a recent visit to the Chatham Islands. The whole surface of these islands, especially Wharekauri and Rangiauria, is covered with a bed of peat in places over forty feet in depth—deeper in the northern part than in the southern—traversable in safety only by those acquainted with the country; for to the inexperienced eye there seems in most places no difference in the surface which can carry with safety both horse and rider, and that on which the lightest-footed pedestrian cannot venture without being engulfed. The surface of some of the larger and wetter depressions in the ground was covered with a brilliant-coloured carpet of luxuriant mosses, emitting an aromatic fragrance, spread out in artless undesigned parterres of rich commingled green, yellow, and purple, and endless shades of these, warning the traveller of the existence of dangerous bogs beneath, and brightening miles of treeless moorland, which, but for those floating gardens, would be uninviting and uninteresting. In many places all over the island this great peat-moss is on fire, and has for years been smouldering underground, or burning in the exposed faces of the great pits which have now been burnt out. Dr. Dieffenbach mentions these fires at his visit in 1840, and states that the combustion had begun before 1834. They appear to have been burning in one part or another of the island ever since Dieffenbach's visit. A peculiarity in the main island that strikes the visitor very early is the occurrence of many lakes and tarns. These lakes are, for the most part, on the eastern side, at the back of the low hills facing Petre Bay. The largest is fifteen miles long, over forty miles in circumference, and about ten and a half miles broad at its widest part.

Mr. Forbes's object in visiting the islands was to look for the remains of a fossil bird, fragments of which had been sent to him in New Zealand. These he discovered in considerable numbers, and found that the bird was no other than a species of *Aphanapteryx*, a large and remarkable member of the rail family, which lived contemporary with the celebrated dodo in the Island of Mauritius, and was very similar to one of the extinct flightless birds of that island. Here was the only place in the world where it was known to exist, and where it had with the dodo preserved its fading race down to about two hundred years ago, when both of them passed away and perished for ever from among living things. In the Chatham Islands the remains of the *Aphanapteryx* were found in kitchen middens of the Morioris, showing that in this region of the world also it had survived down to comparatively recent date, just as the moa had in New Zealand.

In the Chatham Islands there still live several types of flightless birds scarcely represented elsewhere, except in widely separated oceanic islands. To account for their distribution it is necessary to reason backwards to former distributions of land and sea. The occurrence of similar forms in the three southern continents and in the islands which lie between them is most easily explained by a former Austral continent of considerable northern extension. The outlines of this continent it is of course impossible to trace with anything approaching to accuracy till we are in possession of a larger number of soundings. But it is not unlikely that the great meridional masses of land—or world ridges—which are probably of primeval antiquity extended to meet prolongations northward of the Antarctic continent. There is some evidence that the direct union of South Africa with the other continents was not for so prolonged a period as the others. The presence of the *Aphanapteryx* and other ocydromine birds both in the Mascarene and in the New Zealand continental Islands supports other evidence pointing to an extension of that area south by Marion and Kerguelen Islands, and of New Zealand south, or of the Antarctic land north, by way of the Macquarrie, Auckland, and Antipodes Islands. It is interesting to observe that the great Pacific trough to the east of the longitude of New Zealand extends far south into the Antarctic region.

It is not necessary to suppose that all the southerly extending arms were connected contemporaneously with an Antarctic continent. It is impossible to account for the presence, for instance, of some South American forms in Australia and not in New Zealand; of Mascarene forms in the New Zealand region and not in Australia, or in Africa, or elsewhere, while we are unacquainted with the orography, the rivers and mountain barriers, of the submerged southern continent; and its various commissures may have been open at one time and closed at another. As there are, moreover, abundant evidences of great volcanic action over all the region, in New Zealand, South America, Mascarenia, and the Antarctic Islands, the permutations and combinations of the ups and downs of these lands, the openings and closings of the gates, paths, or stepping-stones, are beyond our computation.

The deductions as to an Antarctic continent, made on biological grounds, are supported by the depth of the circumpolar sea, so far as it is known. The submarine plateau of the Austral land slopes northward all round the shores of the known lands more gently than is the case along any other coast, and this would seem to indicate that, if elevated, the land would form in great extent a continuation of the three primal ridges of the globe southward, coalesced and spread out round the Pole, with, between these arms, the terminations of the great and permanent ocean troughs. How far these hypotheses—which are but a restatement, in great measure, of the investigations and conclusions of many distinguished naturalists, geologists, and geographers may be substantiated or refuted by future discoveries it is difficult to say; but the discovery of these interesting *Aphanapteryx* bones on the Chatham Islands must always remain an important factor in the solution of this question.

There was an animated discussion.

ARCHÆOLOGICAL WORK IN AMERICA.

IN his report, just issued, on the Peabody Museum of American Archæology and Ethnology, Prof. Putnam is able to record the results of a very exceptional amount of useful work. This is due to the fact that while the officers of the Museum have discharged their usual duties many special archæological and ethnological researches have also been carried on with a view to the collection of material for the Chicago Exhibition. Prof. Putnam says:—

Never before has such an extensive field of anthropological research been covered in two years' time, and it is desirable to place on record what has been accomplished. In the north,

Lieutenant Peary's expedition to Greenland has brought back a valuable collection from the little known tribe of Eskimo at Whale Sound, including their summer houses of skins, their boats, sledges, weapons, implements, utensils, ornaments; full sets of garments and carvings in ivory, as well as several hundred photographs of individuals of the tribe and of scenes illustrating their daily life; also several crania, and a complete census of the tribe with a full set of anthropometrical measurements and observations. In Labrador, the Skiles expedition (upon which I obtained positions for two Harvard students, one as a naturalist and the other as astronomer) has brought back 57 of the Labrador Eskimo,—men, women, and children with all their belongings,—making an Eskimo village now on the Fair grounds in Chicago, where it will remain until the Fair is over. On the Pacific side Dr. Sheldon Jackson has made ethnological collections in Alaska, and also among the coast tribes of Siberia. Mr. Cherry has collected from the tribes of Yucon valley; and by seven other assistants a systematic collection has been made on the north-west coast, between the Columbia River and Alaska, particularly from northern Vancouver and the Queen Charlotte Islands. On the Saskatchawan Mr. Cowie has made a complete collection to illustrate the life and customs of the tribes of the valley.

Arrangements have been made with the Canadian Commissioner of Indian affairs by which the interior tribes of Canada will be represented living on the Fair grounds; and by the cooperation of the Canadian Government World's Fair Commission a representation of the archæology of Canada has been secured. In the eastern portion of Canada Mr. Tisdale and Mr. Fenollosa, both Harvard students, have collected anthropological data, and much of ethnological importance. Nearly all the Indian tribes of the United States have been visited by students from Harvard and other universities for the purpose of obtaining anthropological data relating to the physical characteristic of the various tribes and of collecting ethnological material. . . .

The State of New York through its World's Fair Commission has also been brought into this work. The Commissioners are earnestly cooperating with me in securing a large archæological collection, and also a thorough representation of the Iroquis tribes. Families from these tribes will be living on the Exposition grounds in bark houses such as were in use when this powerful nation first came in contact with our race.

South of the United States, the Bureau of Latin-American Republics in connection with the State Department has been working with the Ethnological Department of the Exposition, of which its forms a section, and a number of officers of the army and navy were detailed to visit the various republics and arouse an interest in the Exposition, and also to make collections in ethnology and archæology under instructions which I furnished for their guidance. These gentlemen have accomplished much ethnological importance, and have secured several collections from the native peoples of Central and South America. Mr. Frederic Ober was sent to the West Indies and made a special research among the Caribs.

In relation to Mexican archæology, Mrs. Zelia Nuttal, acting in her double capacity as honorary assistant in the Museum and in the Ethnological Department of the Exposition, has been engaged in a search for objects in Europe, brought there at the time of the Spanish conquest, and has found several interesting things, connected with the period of Cortez, of which she has had facsimiles made both for the Exposition and for the Museum.

Further South in Mexico, Consul E. H. Thompson has continued the work in connection with his explorations for the Museum among the ancient ruins of Yucatan. During this time he has made about 10,000 square feet of moulds of portions of the ruined buildings, showing the façades, parts of corners of structures, doorways, and the great recess with its pointed arch of the so-named "House of the Governor" at Uxmal. He has also moulded both sides of the famous Portal at Labna. Casts are to be made from these moulds in Chicago, and there will be seen on the Exposition grounds facsimiles of these elaborately carved stone structures of Yucatan, over and around which will be the tropical plants native to the region of the ruins. As this work by Mr. Thompson was in connection with his explorations for the museum, we can secure such casts from the moulds as we may desire at the cost of making the casts, which, however, will be several thousand dollars.

The Museum Expedition to Honduras, which is an important part of the work of the year, will be specially mentioned further on, but as it forms a link in the chain of explorations it is referred to in this geographical review. Farther south, Mr. G. A. Dorsey, a graduate student in this department of the University, working as a special assistant for the Exposition, has made extensive and important explorations on the Island of La Plata, Ecuador, and in Peru and Bolivia, where he collected a large amount of material. Lieutenants Safford and Welles have secured series of garments, weapons, and other objects illustrating the tribes of portions of the interior of South America. Other officers sent out by the Latin-American Bureau have been farther south, and Patagonia and Tierra del Fuego have been drawn upon for representations of their ethnology.

Returning to the United States, archæological work has been carried on in Ohio by Dr. Metz, Mr. Saville, Mr. Moorhead, Mr. H. I. Smith and Mr. Allan Cook. In the Delaware valley, Mr. Ernest Volk, who in previous years was in the field with me, has been engaged in making a careful exploration of several ancient village sites, burial places, and workshops or quarries, where stone implements were made. Mr. Allan Cook of the University also made a brief study of a small burial-place on Cape Cod. Mr. M. H. Saville, a student assistant in the Museum, examined an ancient soapstone quarry in Connecticut from which interesting specimens were obtained both for the Museum and Exposition; and several gentlemen, particularly Dr. F. H. Williams, Mr. Wm. C. Richards and Mr. James Shepard, who showed him much courtesy, gave to the Museum a number of stone implements found on and near the old quarry. In Maine, Mr. C. C. Willoughby working entirely for the Museum, explored two singular burial-places in the Androscoggin valley in which the graves were so old that the skeletons had entirely disappeared, leaving in the graves only masses of red ochre and numerous implements and other objects of stone. This exploration was conducted in a careful manner and the notes, drawings, and photographs of the objects in place show how thoroughly the work was done. A fine lot of implements in perfect condition was found by Mr. Willoughby, and several others obtained in former years from the same place were given to the Museum by Mr. Elijah Emerson of Bucksport. This remarkable collection will be exhibited in Chicago as part of the Peabody Museum exhibit and will afterwards be arranged in the Museum. At the request of Mr. T. H. B. Pierce of Dexter, Me., Mr. Willoughby also made a partial examination of a mound near Dexter which may be a burial mound. Further exploration should be made, for if it prove to be a burial mound it would be the only one known in New England.

Important researches in physical anthropology have also been carried on. These were in part based on the observations made by the assistants among the native tribes, and in part upon collections. In this connection Dr. Franz Boas, aided by Dr. G. M. West and two clerical assistants, has been engaged in the museum in classifying the anthropological data and in preparing charts, tables, and diagrams to illustrate this subject at the Exposition. Thus for the first time there is being prepared a presentation of the physical characteristics of the native American peoples. Measurements have also been taken, and observations made, on more than fifty thousand children in the public schools in different parts of the United States and Canada, as well as on those in the Indian schools, and on many negro children. In this connection we have secured the cooperation of the authorities of the Japanese schools, and of those of the Hawaiian Islands. We shall thus have the measurements of a number of Japanese and Kanaka children for comparison. To this series of physical measurements has been added a series of tests relating to the mental development of children. These observations and deductions will not only furnish data of importance to educators, but there is reason to believe, from what has already been accomplished in this direction, that they will also give the basis upon which decided reforms in certain directions will be established. It is almost needless to say that the details of this part of the work are entrusted to Dr. Franz Boas, who is my earnest collaborator in connection with the Exposition.

This brief review of the work of about 100 assistants shows how much has been done during the year; and as the Peabody Museum is the place from which it has all been directed, and as much of the work has been done by my regular assistants and students, it is eminently proper to refer to it in this report as showing the relation of the Museum to anthropological research in America. It must also be remembered that the directors of the World's Columbian Exposition have not only given to me this grand opportunity for research, but that it has been largely paid for by the funds subscribed by the citizens of Chicago. Never before has there been a year when so much money has

been expended for pure research in anthropology under one direction as during the past year; and praise and honour are due to the business men forming the directory of the Exposition in Chicago, who have so cordially met my proposals and furnished the means for carrying them out on so grand a scale. Notwithstanding the vast material interests involved in the Columbian Exposition, it must be admitted that Chicago has nobly supported pure science in this connection and has shown an appreciation of its high aims.

On the Honduras Expedition Prof. Putnam reports as follows:—

It was stated in the last report that an expedition had just started to make the preliminary explorations for the ancient ruins of Copan, and in that report is given a brief outline of the origin and plans of this undertaking on the part of the Museum to be carried on by the assistance of patrons of archæological research. It is indeed a pleasurable duty to announce that the first season's work of the expedition has proved a decided success; and that although the party had many trials and difficulties to overcome, no serious accidents or sickness occurred. Messrs. Saville and Owens returned in safety, in May last, bringing with them a large number of most interesting and important objects illustrating the wonderful carvings in stone; several vessels and many fragments of pottery; numerous ornaments made of stone, shells and bone; stone implements; and portions of human skeletons. Among the latter are several incisor teeth, each of which contains a small piece of green stone, presumbly jadeite, set in a cavity drilled on the front surface of the tooth. We had before received from very ancient graves in Yucatan human teeth filed in a peculiar manner, and now we have teeth from the ancient graves in Copan ornamented in another way. This is of particular interest in adding one more to the several facts pointing to Asiatic arts and customs as the origin of those of the early peoples of Central America. A most striking resemblance to Asiatic art is noticed in several of the heads carved in stone,—one in particular, if seen in any collection and not labelled as to its origin, would probably pass almost unchallenged as from Southern Asia. These may prove to be simply coincidences of expression of peoples of corresponding mental development brought about by corresponding natural surroundings and conditions. At present we must admit that there are many resemblances in architecture, sculpture, ornament, and religious symbolism, between Central America and portions of Asia. The true meaning of these resemblances will be made known as authentic materials for study are obtained by such thorough and exhaustive field work as the Museum has been carrying on; and none is so important for this special subject as that of the Honduras expedition. For this work, however, a large sum of money is required. The ten years allowed for the work in Honduras by the edict of that government must be utilised to the fullest extent; and each year must find the Museum ready to put its party in the field well equipped and provided with money for the very expensive work to be performed.

It is not my intention to give an abstract of the results of last year's explorations at Copan. It is far better that the report should be carefully prepared by those engaged in the actual field work from year to year. After sufficient information has been obtained about the ruins themselves, and the architectural and chronological relationship of the various structures; and after a thorough knowledge of the different modes of burial has been acquired, and all possible objects have been collected, then conclusions can be drawn which will be of scientific value, since they will be based on a thorough knowledge of all the facts. An important beginning was made by the expedition last year, plans of the plaza and of the principal structures forming the great mass of the ruins having been made, many photographs taken, and paper moulds of important sculptures, lines of hieroglyphs and several of the large idols or carved monoliths secured. Considering the difficulties of transportation (wholly by mules to the coast—a seven days' journey), both Messrs. Saville and Owens, and all associated with them must be congratulated on what they accomplished. Since the return of the expedition the photographs have been printed, preliminary reports have been prepared, and casts have been made from the moulds. These casts are now being placed in the Museum, and a series has also been made for the Boston Art Museum, and another for the Columbian Exposition.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Prof. Liveing announces a course of demonstrations in spectroscopic chemistry, to be given during the first three weeks of the Easter term, daily (except on Saturdays) at 11, beginning on April 24.

The examination in Sanitary Science for the Diploma in Public Health will be held from April 4 to April 8.

The honorary degree of Doctor in Science will be conferred on Prof. Virchow, at a special congregation on Tuesday, March 21.

A grant of £65 has been made from the Worts Travelling Scholars' Fund to H. Woods, of St. John's College, for the purpose of palæontological research in Saxony and Bohemia.

Lawrence Crawford, B.A., Fifth Wrangler, 1890, has been elected to a Fellowship at King's College.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 16.—"The Value of the Mechanical Equivalent of Heat, deduced from some Experiments performed with the view of establishing the Relation between the Electrical and Mechanical Units, together with an Investigation into the Capacity for Heat of Water at different Temperatures." By E. H. Griffiths, M.A., Assistant Lecturer, Sidney Sussex College, Cambridge, assisted by G. M. Clark, B.A., Sidney Sussex College, Cambridge. Communicated by R. T. Glazebrook, F.R.S.

If a calorimeter is suspended in a chamber, the walls of which are maintained at a constant temperature, we can, by observations over a *small* range across that outside temperature, deduce the rate of rise due to the mechanical work done in the calorimeter, when the supply of heat is derived from stirring only. By repeating the observations in a similar manner over ranges whose mean temperature θ_1 differs from that of the surrounding walls θ_0, we obtain the change in temperature due to the combined effects of the stirring, radiation, conduction, and convection at all points of our whole range of temperature. As the success of the method depends (1) on the possibility of maintaining the exterior temperature unchanged, and (2) on the regularity of the supply of heat due to the stirring, we briefly indicate our method of securing those conditions.

1. The calorimeter [1] was suspended within an air-tight steel chamber. The walls and floor of this chamber were double, and the space between them filled with mercury. The whole structure was placed in a tank containing about 20 gallons of water, and was supported in such a manner that there were about 3 inches of water both above and beneath it. The mercury was connected by a tube with a gas regulator of a novel form, which controlled the supply of gas to a large number of jets. Above those jets was placed a flat silver tube, through which tap water was continually flowing into the tank, all parts of which were maintained at an equal temperature by the rapid rotation of a large screw. Thus, the calorimeter may be regarded as suspended within a chamber placed in the bulb of a huge thermometer—the mercury in that bulb weighing 70 lbs. A change of 1° C. in the temperature of the tank water caused the mercury in the tubes of the regulating apparatus to rise about 300 mm. Special arrangements were made by which it was possible to set the apparatus so that the walls surrounding the calorimeter could be maintained for any length of time at any required temperature, from that of the tap water (in summer about 13° C. in winter 3° C.) up to 40° C. or 50° C. We know by observation that the temperature of the steel chamber (when once adjusted) did not vary by 1/500° C., and we believe the variations were much less.

2. We experienced great difficulty in devising a suitable form of stirrer; and we attribute the failure of our earlier experiments to defects in the ordinary forms. We find it impossible, without a lengthy description, to give a clear idea of the stirrer ultimately adopted. We can only state here that it was completely immersed when the depth of the water exceeded 1 cm., that

[1] The calorimeter was of cylindrical form, and suspended by three glass tubes. It was made of "gilding metal," which both internally and externally was covered with a considerable thickness of gold. All metal surfaces within the calorimeter were thickly gilded.

its bearings were outside the steel chamber, and that the water was thrown from the bottom to the lid of the calorimeter.

More than 100 experiments were performed (many of them lasting several hours) in order to determine the value of $\sigma + \rho\,(\theta_1 - \theta_0)$,[1] when the calorimeter contained different masses of water. The harmony amongst the results was satisfactory.

The pressure in the space between the calorimeter and the walls of the steel chamber was reduced, as a rule, to between 0·3 and 1·0 mm.[2]

The absolute value of the loss by radiation, &c., at different pressures was ascertained, and it was found that the rate of gain or loss decreased very rapidly when the pressure was reduced below 0·5 mm.

If $\left(\frac{\delta\theta_1}{\delta t}\right)_{\sigma,\,\rho}$ is the rate of rise due to the non-electrical supply, and $\left(\frac{\delta\theta_1}{\delta t}\right)$ that due to the electrical supply, then

$$\frac{\delta\theta_1}{\delta t} = \left(\frac{\delta\theta_1}{\delta t}\right)_e + \left(\frac{\delta\theta_1}{\delta t}\right)_{\sigma,\,\rho} \quad \ldots\ldots (1)$$

We have indicated the manner in which we determined the last term of this equation, and thus, by direct observation of $\frac{\delta\theta_1}{\delta t}$, we were able to obtain the value of $\left(\frac{\delta\theta_1}{\delta t}\right)_e$ and

$$\left(\frac{\delta\theta_1}{\delta t}\right)_e = \frac{E^2}{J.R'.M'} \quad \ldots\ldots\ldots (2)$$

where R′ is the resistance of the coil, and M′ the capacity for heat of the calorimeter and its contents at a temperature θ_1.

Throughout the experiments E was kept constant, the arrangement for maintaining the ends of the coil at a constant potential difference worked admirably, and it is probable that in no case did the variations exceed 1/10,000 of the mean potential difference during each experiment.

The value of R was determined by a direct comparison (conducted by Mr. Glazebrook) with the B. A. standards and values of R were expressed in true ohms as defined in the B. A. Report, 1892.

The difference between the temperature of the coil and that of the surrounding water was ascertained, and the resulting difference of resistance was found to be such that $\delta R = \cdot 00422 n^2$, where n was the number of Clark cells by which the potential difference at the end of the coil was maintained.

The mercury thermometers were standardised by direct comparison with several platinum thermometers, and a further comparison has (through the kindness of Dr. Guillaume) been made with the Paris hydrogen standard. The difference obtained by the two methods in the value of the range is only ·005° C.

The various quantities in equation (2) having been determined (with the exception of J and M′), we can deduce from equation (2) the time (T) of rising 1° C at any point of our range when R = 1ω and E is the potential difference of one Clark cell at 15° C.

We thus get

$$\frac{J}{E^2} M' = T \quad \ldots\ldots\ldots\ldots (3)$$

If w be the weight of water, and w_x the water equivalent of the calorimeter at the standard temperature, and if f and g be the temperature coefficients of their specific heats, then

$$M' = w(1 + f\overline{\theta_1 - \theta}) + w_x(1 + g\overline{\theta_1 - \theta});$$

hence

$$\frac{J}{E^2}\{w(1 + f\overline{\theta_1 - \theta}) + w_x(1 + g\overline{\theta_1 - \theta})\} = T \quad . . (4)$$

By repeating observations with different weights of water, w_1 and w_2, and observing T_1 and T_2, the corresponding times, we obtain by subtraction

$$\frac{J}{E^2}(w_2 - w_1)(1 + f\overline{\theta_1 - \theta}) = T_1 - T_2 \quad . . . (5)$$

Hence when $\theta_1 = \theta$ (*i.e.* at the standard temperature) we can find J without first ascertaining the values of f, g, or the water equivalent of the calorimeter, and by repeating the observations over different ranges we can find f without previously obtaining J; or, having obtained f, we can find w_x and g, and then by equation (4) deduce the value of J from a single experiment. We have adopted both methods as a check upon the calculations, which involve much arithmetic. The latter method is the more convenient, as it enables us to ascertain the results of separate experiments, but it cannot be applied until the values of f, g, and w_x have previously been obtained by observations on two different weights at two different temperatures.

We give the values of T at 15°, 20°, and 25° C.

TABLE XLI.—VALUES OF T AT 15°, 20°, AND 25° C.

Temp.	Series I.		Series II.		
	Group B. w = 188·065.	Group E. w = 277·931.	Group A. w = 139·776.	Group C. w = 199·674.	Group D. w = 259·500.
15·000	557·14	740·46	458·87	580·95	702·91
20	557·62	740·60	459·35	581·25	703·05
25	558·09	740·75	459·81	581·55	703·20
No of col. } 1	2	3	4	5	6

From this table we obtain the following results:—

Specific heat of water at 25° in terms of water at 15°, deduced from columns 4 and 6	= 0·99734
Ditto from columns 4 and 5	= 0·99722
Ditto from columns 5 and 6	= 0·99746
Mean	= 0·99734

Hence, adopting 15° C. as the standard temperature, the

SPECIFIC HEAT OF WATER = $1 - 0{\cdot}000266\,(t - 15)$.[1]

Also by means of equation (15) we get the following values of J:—

Columns 4 and 6	J = 4·1939 × 10^7
,, 4 ,, 5	J = 4·1940 × 10^7
,, 5 ,, 6	J = 4·1940 × 10^7
Mean	J = 4·1940 × 10^7

This value of J, as previously pointed out (equation 5), is entirely *independent of the value assigned to the water equivalent of the calorimeter*.

And we find the water equivalent of the calorimeter at 15° C. in terms of water at 15° C. = 85·340 grams. The water equivalent of the calorimeter at 25° C. in terms of water at 15° C. = 86·174 grams.

Hence water equivalent = $85{\cdot}340\{1 + 0{\cdot}000977(t - 15)\}$.

We can now find the capacity for heat of the calorimeter and contents for any weight of water at 15°, 20°, and 25° C., and deduce the value of J from each group separately.

TABLE XLIII.—VALUES OF J.

Group.	15°	20°	25°	Mean.
A	4·1940 × 10^7	4·1940 × 10^7	4·1939 × 10^7	4·1940
B	4·1930 ,,	4·1941 ,,	4·1949 ,,	4·1940
C	4·1939 ,,	4·1938 ,,	4·1937 ,,	3·1938
D	4·1940 ,,	4·1939 ,,	4·1940 ,,	4·1940
E	4·1938 ,,	4·1940 ,,	4·1943 ,,	4·1940
				4·1940

We have in the above table given the values resulting from the calculation at different temperatures, for the limit of our experimental errors is thus clearly indicated, since the values of

[1] σ = rise in temperature per 1 second due to the stirring. ρ = gain or loss in temperature per 1 second due to radiation, &c., when $\theta_1 - \theta_0$ = 1° C.

[2] The pressures were ascertained by a McLeod's gauge.

[1] Over the range 14° to 26° C.

J ought (in the absence of experimental errors) to be identical at all temperatures. The close agreement between the values from different groups, and from the same group at different temperatures, is a satisfactory proof of the accuracy of our determination of the water equivalents of the calorimeter, and of the changes in it and in the capacity for heat of the water.

Hence, if we assume

1. The unit of resistance as defined in the "B.A. Report," 1892;

2. That the E.M.F. of the Cavendish Standard Clark cell at 15° C. = 1·4342 volts;[1]

3. That the thermal unit = quantity of heat required to raise 1 gram of water through 1° C. at 15° C.,

the most probable value of

$$J = 4{\cdot}1940 \times 10^7.$$[2]

This, by reduction, gives the following:—

$J = 427{\cdot}45$ kilogramme-metres in latitude of Greenwich ($g = 981{\cdot}17$).

$J = 1402{\cdot}2$ foot-pounds per thermal unit C in latitude of Greenwich ($g = 32{\cdot}195$).

$J = 778{\cdot}99$ foot-pounds per thermal unit F in latitude of Greenwich ($g = 32{\cdot}195$).

The length of this abstract is already unduly great, and we will, therefore, not enter on any discussion of the results beyond remarking that if we express Rowland's value of J in terms of our thermal unit we exceed his value by 1 part in 930, and we exceed the mean of Joule's determination by 1 part in 350.[3]

The difference between Rowland's value of the temperature coefficient of the specific heat of water and ours would, however, cause both his and our values of J to be identical if expressed in terms of a thermal unit at 11·5° C.

March 2.—"The Effects of Mechanical Stress on the Electrical Resistance of Metals." By James H. Gray, M.A., B.Sc., and James B. Henderson, B.Sc., International Exhibition Scholars, Glasgow University. Communicated by Lord Kelvin, P.R.S.

This investigation was begun for the purpose of obtaining an easily worked method of testing the effect of any mechanical treatment on the density and specific resistance of metals.

For alteration of density, copper, lead, and manganese copper wires were tested. The effect of stretching was always to diminish the density, the alteration being small however: for copper about ½ per cent., and for lead ⅕ per cent. The effect of drawing through holes in a steel plate was somewhat greater, showing at first an increase of 2 per cent.; and, when the drawing was continued, the density began to diminish till, after drawing from diameter 2 mm. to 1·3 mm., it showed an increase on its original value of $\frac{9}{10}$ per cent. Several other interesting results on alteration of density were obtained.

The most important part of the investigation, however, relates to the alteration of specific resistance of copper, iron, and steel wire due to stretching; and, in connection with this, the authors wish particularly to emphasise the advantages to be gained from using the unit of specific resistance introduced by Weber, who always defined it in weight measure, that is, as the resistance of a length of the metal numerically equal to its density and section unity.

The conclusions arrived at are that for practical purposes any mechanical treatment, however severe, does not affect the electrical properties of the metals tested. As contrasted with this, it is interesting to note that the smallest impurity in the metal produces a greater change than the most severe mechanical treatment. For example, an impurity of ⅖ per cent. lowers the electrical conductivity by 13·5 per cent., while an impurity of ⅘ per cent. lowers it as much as 30 per cent.

"A New Hypothesis concerning Vision." By John Berry Haycraft, M.D., D.Sc. Communicated by E. A. Schäfer, F.R.S.

The author pointed out that when a blue pigment is mixed with its complementary pigment—orange-yellow—it makes a grey, not a green as is generally stated. This can be shown by the use of transparent colours, such as watery solutions of the aniline dyes. When you mix an opaque oil blue with its complementary orange-yellew and get a green it is because the light only passes through a very thin superficial film of the mixture, and a paint which is orange-yellow in the mass is only a pale yellow in a thin film, and transmits the green spectral rays stopped by the orange-yellow. In this case, therefore, the thin film of paint which alone affects the light is not a mixture of blue and its complementary orange-yellow, but only a mixture of blue and pale yellow.

In the case of Maxwell's colour discs you get a grey if the blue and yellow are complementary, or a green or red if they are not, just as in the case of mixtures of transparent pigments. Complementary pigments are simply those which between them absorb all spectral rays; thus blue absorbs red, yellow, and some green, and the complementary orange-yellow absorbs violet, blue, and some green. A mixture of these pigments on the palette—if transparent enough—or on the Maxwell's disc absorbs, therefore, the light which falls upon it from all parts of the spectrum in about equal proportions. If examined by the spectroscope the mixture of pigments and the rotating disc both give a dim, unbroken spectrum identical with that of white paper held in half light. In our study of vision we have to deal with the stimulus—spectral rays—and the resulting sensations. Inasmuch as the stimulus—the light of a dim, unbroken spectrum—is the same whether the eye looks at a mixture of blue and orange yellow on a palette, at a Maxwell's disc, or again at a piece of white paper held in half light, the resulting sensation must in all cases be the same—we call it grey or white. In the case of the rotating Maxwell's disc experiment we are not dealing with the fusion of blue and orange-yellow sensations, but the adding together of two halves of the spectrum to make a whole one. Once understood, the physiologist will discard the experiment altogether, as it has no bearing upon colour vision.

The work of Sprengel, Darwin, and especially of Sir John Lubbock, shows that the colour sense has gradually been evolved by the coloured environment of the species. We may infer that in the ancestral condition in which light was distinguished from darkness, but blue was undistinguishable say from red, all visual stimuli were felt as white or various shades of grey. The greater the amount of spectral light the nearer the sensation approached white. This, if accepted, explains why the outer and less used parts of the retina are colour blind in the human eye at the present day, and further explains why a minimal stimulus from a coloured object gives rise to a sensation grey. Just as we may smell something, but require to "sniff," in order to make out what it is, so the coloured object held far away may give rise only to the primitive sensation grey, and has to be brought nearer in order that its colour quality can be felt.

We may explain the fact that an artificial mixture of spectral green and red gives rise to the sensation yellow by the fact that all coloured objects which send to the eye red and green rays also send the intermediate yellow; these objects give rise to the sensation yellow, and we call them by that name. Inasmuch as this association of red and green rays has in the evolution of the eye always combined with yellow rays to produce the sensation yellow, we can explain, as an instance of association, the fact that artificially combined red and green rays produce a yellow sensation.

When, say, red and blue-green spectral rays are artificially combined, they produce a grey sensation, and this we can explain by the fact that no fully coloured natural object sends to the eye such a combination, which combination, therefore, played no part in the evolution of the colour sense, and it produces merely a primitive sensation of simple brightness—white or grey.

That a coloured object brightly illuminated appears white follows the law of maximal stimulation, for in this case the object absorbs so slight a proportion of the light from any one part of the spectrum that that part gives rise to its maximal effect, and the rest of the spectrum can do no more. In this case, therefore, the eye is affected equally (maximally) by all parts of the spectrum, and we have of course the sensation of white.

The above view is an attempt to explain some of the facts of vision by showing that they are on all fours with other facts known to the physiologist. This seems to the author a more scientific method than the one adopted by Young and Helmholtz, who "conceive" a visual apparatus, and endow it with such properties as will, in their opinion, account for the facts of visual sensation.

[1] If we assume the E.M.F. of our Clark cells to be the same as that of the Cavendish standard (and we are inclined to think we have over-estimated the difference), we get $J = 4{\cdot}1930 \times 10^7$.

[2] The value obtained by us in 1891 $= (4{\cdot}192 +) \times 10^7$.

[3] Rowland obtained the mean value of Joule's determinations by assigning values to different experiments, and the above comparison refers to the numbers thus obtained. If, however, we attach equal weight to all Joule's results, as reduced by Rowland, the mean *exceeds* our value by 1 in 4280, assuming our expression for the temperature coefficient of the specific heat of water.

Chemical Society, February 16.—Prof. A. Crum Brown, F.R.S., President, in the chair.—It was announced that the following changes in the Council were proposed by the Council for the ensuing year:—President, Prof. H. E. Armstrong, vice Prof. Crum Brown. Vice-Presidents: Dr. E. Atkinson and Mr. C. O'Sullivan, vice Prof. Hartley and Mr. Warington. Secretary, Prof. Dunstan, vice Prof. Armstrong. Ordinary Members of the Council: Messrs. C. F. Cross, Bernard Dyer, Lazarus Fletcher, and W. A. Shenstone, vice Mr. H. Bassett, Prof. Ferguson, Mr. J. Heron, and Mr. S. U. Pickering.—The following papers were read: Note on the preparation of platinous chloride, and on the interaction of chlorine and mercury, by W. A. Shenstone and C. R. Beck. The authors find that very pure specimens of chlorine may be prepared by igniting platinous chloride obtained by heating hydrogen platinichloride in a current of dry hydrogen chloride. On passing the dry gas for fifteen hours over the platinichloride at the boiling point of mercury and igniting the residue *in vacuo*, chlorine was obtained which contained 99·84 per cent. of the gas. A portion of the platinous chloride obtained in this experiment was heated at 500° in a current of dry hydrogen chloride during many hours; on then igniting the residue, chlorine was evolved which when treated with mercury only left a residue of 0·06 per cent. unabsorbed. The platinous chloride made by the above method probably contain a little platinum, but as a source of chlorine, it seems to be superior to the product of more familiar processes. The second sample of chlorine mentioned above acted very sluggishly on mercury; this fact, considered in connection with the great purity of the gas, supports the authors' view that the activity of chlorine towards mercury is probably due to the presence of impurity in the former.—The action of phosphoric anhydride on fatty acids. Part III., by F. S. Kipping. In the present paper the author shows that caprylone $(C_7H_{15})_2CO$, nonylone $(C_8H_{17})_2CO$, and myristone $(C_{13}H_{27})_2CO$, can be readily prepared from the corresponding fatty acids by the action of phosphoric anhydride; a number of derivatives of these ketones are described. Mixed ketones of the general formula R.CO.R′ are produced when a mixture of two fatty acids is treated with phosphoric anhydride at a moderately high temperature; the mixed ketone is, however, accompanied by two simple ketones. Treatment with phosphoric anhydride would seem to be one of the simplest and most rapid methods by which the ketone $(C_nH_{2n+1})_2CO$ can be prepared from a fatty acid $C_nH_{2n}O_2$.—Regularities in the melting points of certain paraffinoid compounds of similar constitution, by F. S. Kipping. The author has prepared and characterised a number of hydroximes, secondary alcohols and ethereal salts derived from the fatty ketones $(C_nH_{2n+1})_2CO$ and draws attention to certain regularities observed on comparing the melting points of these compounds. The melting points of all ketones of the general formula $C_nH_{2n}O$ cannot be calculated by means of the formula given by Mills (*Phil. Mag.* 1884), inasmuch as isomeric ketones frequently melt at different temperatures.—Some relations between constitution and physical constants in the case of benzenoid amines, by W. R. Hodgkinson and L. Limpach. A study of the formyl and acetyl derivatives of certain homologues of aniline shows, (1) that the entry of alkyl groups into the nucleus affects the melting and boiling points in a regular manner; (2) that the conversion of formyl into acetyl also involves an alteration in physical properties in extent the same as that produced by introducing CH_3 into the nucleus in an ortho- or para-position relatively to the amido-group, and (3) that the same (or any?) alkyl group entering the nucleus in the meta-positions has no effect on melting or boiling point. Several numerical regularities are also apparent.—Electrolysis of sodic ethylic camphorate, by J. Walker. On electrolysis, sodium ethyl camphorate yields the ethyl salts of two new acids, viz. campholytic acid, C_8H_{13} . COOH, and camphotetic acid, $C_{16}H_{28}(COOH)_2$. The first of these is a monabasic, unsaturated acid boiling at 240–242°. It is lævo-rotatory, but gives a dextro-rotatory ethyl salt. Camphotetic acid is a colourless crystalline solid, melting at 132°; it behaves as a saturated, bibasic acid and forms well-characterised salts. Judging from the nature of the electrolysis and the behaviour of campholytic acid towards bromine, camphoric acid should contain the group

$$\begin{array}{l} \quad | \\ \mathrm{HC\ .\ COOH} \\ \quad | \\ \mathrm{—C\ .\ COOH} \\ \quad | \end{array}$$

—The hydrates of hydrogen chloride, by S. U. Pickering. Determinations of the densities of aqueous solutions of hydrogen chloride show a strongly-marked break indicative of the presence of a trihydrate. The author has obtained this hydrate in the solid state by making a series of freezing-point determinations; it forms large, transparent crystals melting at –24°·9. The densities also indicate the existence of a change of curvature at a point corresponding to a hexhydrate; the freezing-point determinations afford no evidence for or against the existence of this substance, but the presence of a decahydrate was indicated.—A new base from *Corydalis cava*, by J. A. Dobbie and A. Lauder. By exhausting crude corydaline with hot water the authors have isolated a new alkaloid of the composition $C_{19}H_{25}NO_4$, which they term corytuberine; this alkaloid contains only two methoxy-groups, whilst corydaline contains four. A number of its salts are described. The authors also give some notes on yet another alkaloid, which they consider to be distinct from all the bases of *Corydalis cava* hitherto described.

February 20.—Lord Playfair, F.R.S., Vice-President, in the chair.—This being the anniversary of the death of Hermann Kopp, Prof. T. E. Thorpe delivered a memorial lecture entitled "The Life Work of Hermann Kopp."

PARIS.

Academy of Sciences, March 6.—M. Lœwy in the chair.—On a partial differential equation, by Émile Picard.—On the spectro-photographic method which makes it possible to obtain photographs of the chromosphere, faculæ, protuberances, &c., by M. J. Janssen. This method was outlined by M. Janssen as early as 1869, at the Exeter meeting of the British Association.—Analysis of the ashes of the diamond, by M. Henri Moissan. All the specimens of the carbonado and Cape diamond analysed contained iron, as shown by the potassium sulphocyanide reaction. This metal formed the larger portion of the ashes. Silicium also occurred regularly, and calcium very frequently. It will be remembered that this alkaline earthy metal was found by M. Daubrée in native iron from Ovifak.—On some new properties of the diamond, by M. Henri Moissan (see Notes).—The pancreas and the nervous centres controlling the glycemic function, by MM. A. Chauveau and M. Kaufmann. The inhibitory action exerted by the pancreas on the glycogenic function of the liver appears to be dependent upon an excito-secretory centre controlling the cells performing the internal secretion of the pancreas. This centre is situated in the encephalic portion of the spinal cord, and the inhibitory impulse acts through this centre upon an excito-secretory centre controlling the glycogenic activity of the liver. The removal of the pancreas eliminates this control, and renders an excessive activity of the liver more serious.—The fixation of torrents and the planting of the mountains, by M. Chambrelent. It has been calculated that in the last forty years France has suffered losses amounting to 700 million francs due to inundations in places where the mountains were not wooded sufficiently to check the ravages of mountain torrents after heavy rain. The Chamber has recently voted a sum of 2,600,000 frcs. for the planting of the mountains, and it is hoped that the work will be completed in twelve or fifteen years.—On the cause of the variations of terrestrial latitude, by M. Hugo Gylden.—On some new derivatives of phenolphtaleïn and fluoresceïn, by MM. A. Haller and A. Guyot.—On the diameters of Jupiter's satellites, by M. J. J. Landerer.—On a class of dynamical problems, by M. P. Staeckel.—On surfaces whose principal planes are equidistant from a fixed point, by M. Guichard.—On a theorem of M. Stieltjes, by M. Cahen.—On a partial differential equation of the second order, by M. J. Weingarten.—On the calculation of stability of ships, by M. E. Guyon.—On electric waves in wires, and electric force in the vicinity of a conductor, by M. Birkeland.—Oscillographs; new apparatus for the study of slow electric oscillations, by M. A. Blondel.—Photographic reproduction of gratings and micrometers engraved on glass, by M. Izarn. Ammonium bichromate in gelatine gives better results than either collodion or silver salts in gelatine. Copies of microscopic divided scales and gratings were obtained easily and with certainty, and reflection gratings were produced by employing silvered instead of plane glass.—Concerning the direct-reading stereo-collimator of M. de Place, by M. R. Arnoux.—On the industrial preparation of aluminium, by M. A. Ditte. The alkaline aluminates are decomposed by water, and even in the presence of an excess of alkali the introduction of a few crystals of aluminium hydrate into the solution suffices to prevent the establishment of equili-

brium and to effect the decomposition of the aluminate, the rapidity of the reaction being increased by well stirring. In the industrial process of obtaining aluminium from bauxite, these crystals are provided by adding to the sodium aluminate a little of the deposit obtained by treating it with a current of carbon dioxide in the cold, a deposit which consists of crystallised aluminium hydrate. The gelatinous hydrate has no such effect. The alumina precipitated is very pure. Substances such as silica and phosphoric acid, dissolved out of the bauxite by the caustic soda employed, remain in solution.—On the isomerism of the amido-benzoic acids, by M. Oechsner de Coninck.—On the dimorphism of the chloroplatinate of dimethylamine, by M. Le Bel.—On inuline and two new proximate bodies—pseudo-inuline and inulenine, by M. C. Tanret.—Absorbing action of cotton on dilute solutions of sublimate, by M. Léo Vignon.—Remarkable resistance of animals of the genus *Capra* against the effects of morphine, by M. L. Guinard.—Alterations of molecular tissue in the barbel due to the presence of myxosporidia and microbes, by M. P. Thélohan.—On the maxillary apparatus of the Eunicidæ, by M. Jules Bonnier.—On the perfume of orchids, by M. Eugène Mesnard. —Experimental researches on the mole and on the treatment of this disease, by M. Julien Constantin.—A disease of the endive, by M. Prillieux; remarks by M. Arm. Gautier.—On the morphology of the cellular nucleus in the Spyrogyras and the resulting phenomena in this plant, by M. Ch. Decagny.—Discovery of *Mastodon Borsoni* at Rousillon, by M. A. Donnezan. —On the use of soluble cartridges in oceanographic measurements and experiments, by M. J. Thoulet.—Temperatures observed in the winter of 1789 at Montbéliard, by M. Contejean.

BERLIN.

Physical Society, January 20.—Prof. Kundt, President, in the chair.—Dr. Haentzsch spoke on the potential equation, gave an historical account of researches bearing on it, and added a communication on the results of his own investigations. Prof. Planck explained the arrangement and principle of a truly-tuned harmonium, built on the system of C. Eitz, and bequeathed to the Physical Institute. The instrument includes four and a half octaves, and possesses special notes, arranged in several rows and distinguished by four different colours, for the fifths, the major and minor thirds, and the major and minor sixths. The pure intonation of the harmonium enables it to be used with far greater success than one which is "tempered," for demonstrating that our ear accommodates itself to concords which are not quite pure, and is influenced in its discrimination of concords by the recollection of tones heard previously. The instrument is not suited for concert purposes.

Physiological Society, February 3.—Prof. du Bois Reymond, President, in the chair.—Prof. Gad opened a discussion on the communication made by Prof. Behring at the last meeting of the Society (see NATURE, vol. xlvii. p. 336). The discussion turned chiefly on the applicability of the results of Prof. Behring's experiments to the treatment of tetanus in man. Dr. Wernicke exhibited diphtheritic cultures which had been kept for more than a year, and still developed rapidly in either agar, gelatine, or broth. He then demonstrated on dissected guinea-pigs the more important symptoms of diphtheritic infection, viz. œdema at the place of inoculation, hyperæmia of the liver, kidneys, and adrenals, serous exudations in the abdomen and thorax. He next exhibited some guinea-pigs which, after inoculation with the bacilli of diphtheria, had been treated with blood-serum from other animals immune to diphtheria and had been thereby cured. It was found that the longer the interval which elapsed after inoculation before the curative serum was administered, the greater was the dose of the serum required to effect a cure. He finally reported on experiments on dogs in which immunity and recovery after inoculation had been similarly attained.

Meteorological Society, February 7.—Prof. von Bezold, President, in the chair.—Dr. Schubert gave an account of recent researches on the influence of forests on the temperature and humidity of the air, with special reference to certain forests in Austria. So far only the experiments made in Podolia in a leafy forest on level ground have led to uniformly positive results. From these it appears that the forest lowers the mean temperature of the air, but only in so far that the temperature at 8 p.m. is much lower than that existing in the open country, that at 2 p.m. it is higher than in the open, and that the daily amplitude of variation is greater in the forest. The speaker had however found, from a careful perusal of the existing data, and from comparative determinations made in the forests near Eberswalde, that the results so far obtained are markedly affected by radiation. The true temperatures of the air inside and outside the forest have not yet been measured, and for this purpose it would be necessary to use an aspiration-thermometer. Determinations of humidity are similarly adversely affected by wind and by evaporation due to air-currents. In this case accurate results would be obtained by means of an aspiration-psychrometer. Prof. Sprung communicated an observation he had made at the Potsdam meteorological institute on the recent coldest day in January. While endeavouring to find the most suitable position for a thermometer, he observed, while using similar aspiration-thermometers, the following simultaneous temperatures at four different places, viz. $-23°$, $-23°$, $-18°$, and $-17°$. The four places were: (1) in an adjoining meadow two metres above the ground; (2) at the north side of the observatory two metres above the ground; (3) two metres above the platform of the tower; and (4) at the cage of the anemometer seven metres above the platform. Hence the temperature at the comparatively slight elevation of the anemometer was 6° higher than at the ground, whereas usually the same four thermometers showed a slight fall of temperature at the greater elevation.

BOOKS RECEIVED.

L'Art de Chiffrer et Déchiffrer les Dépéches Secrètes: Marquis de Viaris (Paris, Gauthier Villars).—Traité Pratique de Calorimétrie Chimique: M. Berthelot (Paris, Gauthier-Villars).—The Poets and Nature: P. Robinson (Chatto and Windus).—The Evolution of Decorative Art: H. Balfour (Percival).—Discussion of the Precision of Measurements: S. W. Holman (K. Paul).—Report of Observations of Injurious Insects and Common Farm Pests during the Year 1892: E. A. Ormerod (Simpkin).—Some Lectures by the late Sir G. E. Paget, edited from MSS., with a Memoir by C. E. Paget (Cambridge, Macmillan and Bowes).—Catalogue of the British Echinoderms in the British Museum (Natural History): F. Jeffrey Bell (London).—Lehrbuch der Allgemeinen Chemie, 2 vols.: Dr. O. Ostwald (Leipzig, Engelmann).—The Mechanics of the Earth's Atmosphere: C. Abbe (Washington).—Das Horizontalpendel: Dr. E. von Rebeur-Paschwitz (Halle).—A Manual of Ethics: J. S. Mackenzie (Clive). —Notes on Astronomy: S. P. Johnston, edited by J. Lowe (J. Heywood). —L'Aquarium d'Eau Douce: H. Coupin (Paris, J. B. Baillière).—Les Lichens: A. Aclocque (Paris, J. B. Baillière).—Éléments de Paléontologie, première partie: F. Bernard (Paris, J. B. Baillière).—Der Nord-Ostsee Kanal: C. Beseke (Kiel, Lipsius and Tischer).—Catalogue of American Localities of Minerals: Prof. E. S. Dana (Gay and Bird).

CONTENTS.

THURSDAY, MARCH 23, 1893.

COLLIERS AND COLLIERY EXPLOSIONS.

Coal Pits and Pitmen. A Short History of the Coal Trade, and the Legislation affecting it. By R. Nelson Boyd, M.Inst.C.E. (London: Whittaker and Co.)

AS the author remarks in his preface, his present work is a re-cast of a book published for him in 1879 by W. H. Allen and Co., under the title of "Coal Mines' Inspection." A casual examination of both books shows that they are alike in their main features; only, the latter work has been extended so as to include some of the events of later years. The subject is divided into twelve chapters, to which are added four short appendices and a good index. The text extends to 239 pages 8vo of good readable print, and there are a few good illustrations of ancient mechanical arrangements, including the steel mill.

Mr. Boyd begins by giving a very short historical account of the situation before Parliament began to interfere in the relations between masters and men. He then describes the circumstances which led to the appointment of successive Royal Commissions, charged to inquire into various matters relating to mines and miners, and he sketches briefly the leading features of the reports presented by these Commissions, together with the chief points of interest contained in the legislative enactments which were founded upon some of them. Our author also pauses from time to time to recount in considerable detail the events of more than passing interest, such as explosions, inundations, and other accidents which happened during the period with which he is dealing; and lastly, in his appendices, he gives the titles of the Acts of Parliament affecting coal mines and miners, both English and Scotch, a list of serious colliery explosions previous to and since 1850, and a table showing the production of coal at different times, commencing in 1660, and brought down to 1891.

Among other more or less important provisions of the Acts of Parliament our author gives prominence to:—The exclusion of women from mines, the appointment of Government inspectors, the limitations of the ages at which boys can be employed, the restrictions under which explosives may be used, the requirement that each mine should have two distinct shafts, that each mine manager must have a certificate similar to that of a sea captain, that payment must be made by weight and not by measure, the conditions under which safety lamps are to be used, and the method of dealing with coal-dust when it is present.

He also reviews such questions as the payment of royalties and wayleaves to landlords, the employers' liability, the wasteful consumption of fuel, the duration of the coal supplies, and old-age pensions to miners.

Contrasting the present with the past he says:—"The workmen of the present day have attained a distinct social position, have representation in the House of Commons, and trade unions, societies, and powerful combinations," whereas formerly the Scotch colliers were *adscriptæ glebæ*, that is, were bought and sold with the land: an Act of the Scotch Parliament of 1660 prohibited them from leaving their employment without a written attestation from their masters under pain of punishment in their bodies, and any person employing them was ordered to return them within twenty-four hours or pay a fine of one hundred pounds Scots. The colliers of the North of England were little better, being hired by the year under a system of binding or bonding; those of the Bristol coal-field were described by contemporary writers as being as brutal and ignorant as savages. Colliers lived apart from the rest of the community, were looked down upon with contempt by their fellow-men, and diverted themselves with bull-baiting, drinking, and debauchery.

The state of serfdom was removed by various Acts of Parliament passed during the latter half of last century, apparently more with the object of increasing the numbers of the colliers by drawing other classes of labourers into the mines than from any specially humanitarian motives. But at length a day dawned when higher principles began to prevail. From 1842, when Lord Ashley's Act was passed for the exclusion of women from the mines, onwards to 1887, one Act was passed after another, each having the same object in view, namely, the amelioration of the lot of the miner.

The frequent occurrence of disastrous colliery explosions and the great destruction of life and property which accompanied them, had done more than anything else to draw the attention of the public to a consideration of mining affairs, and had likewise been the principal incentive to the appointment of Royal Commissions and to the passing of Acts of Parliament to regulate the supervision and the working of mines.

Notwithstanding all that had been done previously, more lives were lost in explosions during the five years ending 1870 than during any preceding five years, the aggregate number lost in fifteen explosions, each of which involved the loss of ten lives and upwards, having amounted to 923.

The Coal Mines' Regulation Act of 1872 was drawn up with great care by Mr. Bruce (now Lord Aberdare), the Home Secretary. It embraced the experience of the Inspectors of Mines, as well as the combined wisdom of mine owners, engineers, managers of mines, and delegates of the colliers. But, firedamp having been hitherto regarded as the sole cause of colliery explosions, the stringent provisions of that Act were directed exclusively towards the detection and removal of that element of danger.

In 1845 Messrs. Lyell and Faraday, who had examined the scene of the Haswell colliery explosion, which they attributed to large accumulations of firedamp in the empty spaces (goaves) from which pillars had been removed, remarked that firedamp had not been its only fuel, but that doubtless the coal-dust which was raised and swept along *by the firedamp flame* would be decomposed by the heat of that flame, and would therefore add to the force of the explosion.

Between the years 1860 and 1875 several French mining engineers were impressed with the idea that coal-dust had played a part in certain explosions which took place in France. Some experiments were made by a committee of the Société de l'Industrie Minérale, and by M.

Vital, one of the Ingénieurs des Mines, with the object of ascertaining the likelihood or otherwise of this hypothesis, but no definite conclusions were arrived at.

In December, 1875, the present writer examined into all the circumstances attending a colliery explosion in South Wales, and gave a minute description of it before a coroner's jury. He insisted that coal-dust had been the principal agent in that explosion, and that firedamp had only played a subordinate part. At the same time he referred to the results of experiments he had made which showed conclusively that when fine dry coal-dust is added to a mixture of air and firedamp, in which the firedamp is present in so small a proportion as to escape detection by the means employed for this purpose in mines, the mixture is inflammable at ordinary pressure and temperature, and when ignited burns like a jet of inflammable gas. In March, 1876, he read a paper before the Royal Society, in which he described these experiments, as well as the apparatus with which they had been carried out. In this paper, also, he claimed that when an explosion is once begun in a dry and dusty mine it becomes self-propagating, and, provided the continuity of the deposit of coal-dust is unbroken, it extends to the utmost limits of the workings. This became known afterwards as the "Coal-dust Theory of Great Colliery Explosions."

In May, 1876, Mr. Hall, one of the Inspectors of Mines, read his first paper on the subject before a meeting of the North of England Institute of Mining and Mechanical Engineers held in London.

During the year 1878 the present writer published a series of papers on "Coal-dust Explosions" in "Iron"; and while they were appearing Messrs. Marrecco and Morrison read their first paper on the subject.

Numerous societies of mining men, and individuals more or less connected with mining, now began to take an interest in the subject, and to make experiments with coal-dust. About this time, also, Commissions were appointed by the Governments of England (Royal Commission on Accidents in Mines 1879), France (Commission du Grisou), Prussia and Austria, to inquire into the causes of mining accidents, and amongst other things to investigate the probable influence of coal-dust in colliery explosions.

This sudden activity was no doubt quickened by the events of the ten years ending with 1880, during which the loss of life from explosions was twice as great as it had been during any previous decade. Taking into account only those explosions in which ten lives and upwards were lost, we find that there were thirty-five explosions, involving the lives of 2014 persons, of which 1411 were attributable to the second half of the decade.

In 1880 Prof. (now Sir Frederick) Abel, one of the English Commissioners, was instructed by the Home Secretary to investigate and make a special report upon the Seaham colliery explosion (September 8, 1880). During the course of these investigations Abel repeated our experiments of 1875-76 with a similar apparatus with practically the same results as far as coal-dust is concerned; but he claimed in addition to have discovered that any very finely divided incombustible dust would render a mixture of air with 3 or 4 per cent. of firedamp inflammable. His apparatus was not, however, provided with any special means of mixing the gas and air such as had been used in our own apparatus, of which it was otherwise a copy.

The German Commissioners erected and made experiments with an apparatus similar to one that we had described to the Royal Society in 1881, but on a somewhat larger scale, and they obtained similar results. Unfortunately, however, they passed away from the main question, viz. whether an explosion that *has taken place* in a dry and dusty mine under the circumstances that would have been formerly described as mysterious, can be attributed to the influence of the coal-dust in the supposed absence of firedamp?

The French Commissioners arrived at conclusions adverse to the coal-dust theory. They made no special experiments with coal-dust on an important scale and they did not, so far as can be gathered from their reports, examine the workings of any mine immediately after an explosion.

The Austrian Commissioners arrived at the conclusion which we had previously stated in this country, namely, that the relative fineness of a dust has far more to do with its relative inflammability than its chemical composition.

The English Commissioners expressed an oracular opinion. They denied on the one hand that coal-dust could be the principal agent in great colliery explosions, for, "If that were the case," said they, "an explosion would happen every day, nay every hour." But, on the other hand, they endeavoured to point out that coal-dust may be an element of the gravest danger under certain circumstances which they proceeded to define in a very precise manner. The Act of 1887 embodies their recommendations regarding safety lamps, explosives, and coal-dust.

From the end of 1875 onwards attention had been more and more directed to the coal-dust question. It had been observed that a great explosion never by any chance took place in a damp or wet mine, that when such an explosion took place in a dry and dusty mine, its progress was always arrested by dampness or wetness or by the absence of coal-dust, that it always passed through the dry intake airways, which contain pure air, and comparatively clean coal-dust, that it frequently avoided the return airways, which contain all the firedamp produced in the workings, but impure coal-dust or only stone-dust, and, lastly, that it spread into all the districts of the workings ventilated by separate and distinct intake and return airways, quite irrespective of the force or direction of the ventilating currents, and dependent only upon the one simple but indispensable condition that the train of dry coal-dust continued unbroken, or was interrupted only for short distances here and there. These facts were proved to demonstration by the researches of a number of independent observers in the mines themselves, immediately after the occurrence of explosions. In vain have the opponents of the coal-dust theory, who were at one time very numerous, urged that the intake airways might have contained firedamp, that the coal-dust cloud raised and ignited by a local disturbance, such as the firing of a blasting shot, probably acted as a connecting link which carried the flame from one accumulation of firedamp to another, that if coal-dust was as dangerous as it was represented to be, an explosion would take place

every day, nay, every hour; that certain kinds of coal-dust were perhaps less inflammable than others, and so on.

Comparatively few have had the advantage of carefully studying the coal-dust flame as well as the opportunity of investigating the minutest details of a series of great colliery explosions in the mines, immediately after their occurrence. The foregoing arguments are therefore perhaps to some extent excusable; but they are none the less the outcome of the imagination of their authors. They are being pressed more and more feebly as time goes on, and they are likely, we think, before many years have passed, to vanish as absolutely as the so-called "outburst of gas" theory which for more than a generation was invariably quoted as the only possible means of accounting for the kind of explosions to which we have been drawing attention.

The late Home Secretary, Mr. Matthews, was so much impressed by the occurrence of great explosions one after the other in dry and dusty mines, that he appointed a Royal Commission on Coal-Dust in 1890. That Commission has not yet issued its report, but the volume of evidence taken before it, which has been lately published, shows to what small proportions the opposition has shrunk since the theory was first started. It is also satisfactory to observe that the number of lives lost in great explosions during the last ten years is only about one half of the number lost during the previous ten years.

W. G.

REVERIES OF A NATURALIST.

Idle Days in Patagonia. By W. H. Hudson, C.M.Z.S., Author of "The Naturalist in La Plata." (London: Chapman and Hall, 1893.)

THE title of this book well describes its contents; but Mr. Hudson has established so high a standard by his previous work that the present volume has something of the character of an anti-climax. In literary style, in picturesque description, and in suggestive ideas and reflections there is no falling off; but we miss the wealth of original observation and ingenious speculation which made "The Naturalist in La Plata" a masterpiece.

Mr. Hudson was wrecked on the shores of Patagonia, and had a weary tramp over the desert, of some thirty miles, to reach the settlement on the Rio Negro. There, and at some farms higher up the valley, he appears to have spent a year or more, doing nothing but wandering about on foot or on horseback, observing the habits and peculiarities of the scanty fauna and flora, noting the varied aspects of nature, and apparently thoroughly enjoying day after day of dreamy idleness. He spent some months at a house about seventy miles up the valley, which was here about five miles wide; and every morning he rode away to the terrace or plateau, covered with grey thorny scrub, and there found himself as completely alone as if he were five hundred instead of only five miles from civilisation. He says:—

"Not once, nor twice, nor thrice, but day after day I returned to this solitude, going to it in the morning as if to attend a festival, and leaving it only when hunger and thirst and the westering sun compelled me. And yet I had no object in going—no motive which could be put into words; for although I carried a gun, there was nothing to shoot—the shooting was all left behind in the valley. Sometimes a dolichotis, starting up at my approach, flashed for one moment on my sight, to vanish the next moment in the continuous thicket; or a covey of tinamous sprang rocket-like into the air, and fled away with long wailing notes and loud whirr of wings; or, on some distant hillside a bright patch of yellow, of a deer that was watching me, appeared and remained motionless for two or three minutes. But the animals were few, and sometimes I would pass an entire day without seeing one mammal, and perhaps not more than a dozen birds of any size."

There was nothing beautiful or even pleasing to be seen in this dreary monotonous solitude, yet he felt a great delight and satisfaction in it, which he imputes to the ancestral savage nature that still exists in all of us, though repressed and overlaid by civilisation and society.

"It was elation of this kind, the feeling experienced on going back to a mental condition we have outgrown, which I had in the Patagonian solitude; for I had undoubtedly *gone back;* and that state of intense watchfulness, or alertness rather, with suspension of the higher intellectual faculties, represented the mental state of the pure savage."

In the second chapter—"How I became an Idler"—we are told of a still more disagreeable adventure than the shipwreck. Mr. Hudson was going with a friend to a farm eighty miles up the valley. On the way they stayed a night at a deserted hut, and here he had the misfortune accidentally to discharge a revolver bullet into his knee, rendering it necessary for him to return to the settlement to be cured, perhaps to save his life. His friend tied up the wound as well as he could, and left him to get a cart from the nearest house a good distance off. He was absent a whole day, Mr. Hudson lying on his back on the ground all the time. When his companion at length returned with the cart, and lifted him up to put him into it, a large and very poisonous snake moved from under his cloak, where it had been lying close to his feet for many hours. It glided away into a hole under the wall, and Mr. Hudson rejoiced "that the secret deadly creature, after lying all night with me, warming its chilly blood with my warmth, went back unbruised to its den."

This accident kept the author for some months in bed, and for other months a convalescent unable to walk far; and thus the finest summer weather was wasted, and he acquired those habits of the country and the people that made him an idler, and prevented him from learning as much of the animal and vegetable life of the country as, under more favourable circumstances, he might have done. Yet he gives us many interesting facts and discussions, and the chapter on "The War with Nature" is one of these. This war begins when man introduces domestic cattle, cultivates the soil, and destroys the larger wild animals for food or sport. In doing this he provides food of an attractive kind for many wild creatures, and the war begins. Pumas devour his cattle; locusts destroy his grass or crops; coots, ducks, geese, or pigeons devour the grain as soon as sown, or feed upon the young shoots, or upon the ripe wheat ready for the harvest; and thus the farmer is kept in a constant state of activity and watchfulness, which really gives him a beneficial excitement in what would otherwise be a most

monotonous and unattractive existence. In one of his glowing passages Mr. Hudson thus describes and personifies the war between nature and man.

"He scatters the seed, and when he looks for the green heads to appear, the earth opens, and lo! an army of long-faced yellow grasshoppers come forth! She too, walking invisible at his side, had scattered her miraculous seed along with his. He will not be beaten by her, he slays her striped and spotted creatures; he dries up her marshes; he consumes her forests and prairies with fire, and her wild things perish in myriads; he covers her plains with herds of cattle, and waving fields of corn, and orchards of fruit-bearing trees. She hides her bitter wrath in her heart, secretly she goes out at dawn of day and blows her trumpet on the hills summoning her innumerable children to her aid. Nor are they slow to hear. From north and south, from east and west, they come in armies of creeping things, and in clouds that darken the air. Mice and crickets swarm in the fields; a thousand insolent birds pull his scarecrows to pieces, and carry off the straw stuffing to build their nests; every green thing is devoured; the trees, stripped of their bark stand like great white skeletons in the bare desolate fields, cracked and scorched by the pitiless sun. When he is in despair deliverance comes; famine falls on the mighty host of his enemies; they devour each other and perish utterly. Still he lives to lament his loss; to strive still unsubdued and resolute. And she, too, is unsubdued; she has found a new weapon it will take him long to wrest from her hands. Out of the many little humble plants she fashions the mighty noxious weeds; they spring up in his footsteps, following him everywhere, and possess his fields like parasites, sucking up their moisture and killing their fertility. Everywhere as if by a miracle, is spread the mantle of rich, green, noisome leaves, and the corn is smothered in beautiful flowers that yield only bitter seed and poison fruit. With her beloved weeds she will wear out his spirit and break his heart; she will sit still at a distance while he grows weary of the hopeless struggle; and at last, when he is ready to faint, she will go forth once more, and blow her trumpet on the hills and call her innumerable children to fall on him and destroy him utterly."

This, the author tells us, is no fancy picture, but one painted from nature in true colours. If so it is not encouraging for emigrants; but then, the climate is superb, and it is a proverb that "once in a hundred years a man dies in Patagonia." Then, again, the bird music is unsurpassed; there are numerous exquisite songsters; and of one of them—the mocking bird, he declares that the song is so varied and beautiful that all the music of our song-thrush might be taken out of it and not be much missed. Azara declared that there were as many and as good songsters in Paraguay and La Plata as in Europe, and Mr. Hudson agrees with him. The reason why Darwin and other travellers thought otherwise is, because most of the South American songsters are shy wood-birds which rarely approach man's dwellings, and are therefore only heard by those who seek them; whereas in Europe they are mostly species which haunt gardens and orchards, and cultivated fields, and are thus more or less familiar to every one.

In a chapter on "Sight in Savages" it is maintained that they have no superiority in this respect to civilised man; and that what often seems like better sight is merely trained observation of objects which it is essential for them to know. There is an amusing story of a middle-aged Gaucho, who laughed and jeered at an Englishman for wearing spectacles, and would not believe that bits of glass over his eyes could possibly make him see better. The gentleman persuaded the man to try them, and they happened exactly to suit his sight, which had gradually grown imperfect without his knowing it. He stared round, utterly amazed, and then shouted:—"Angels of heaven, what is this I see! What makes the trees so green—they were never so green before! I can count their leaves! And the cart over there—why it is red as blood." And he went up to it to be sure it had not been fresh painted. There is also a chapter—"Concerning Eyes"—dealing with their characteristic colours, their scintillation under excitement, and the uses of these peculiarities, a subject to which Mr. Hudson has given much attention. Many old Indian burial places and village sites were found, with abundance of arrow-heads, flint knives, scrapers, mortars and pestles, stone anvils, pottery, and other objects. There were two kinds of arrow-heads, some large and very rude, others smaller and exquisitely finished, the former found mostly on the plateau, the latter in the valley. One of the village sites, where the greatest number of objects was found, had been buried seven or eight feet, and was exposed by heavy rains, which had washed away great masses of gravel and sand. Many of the smaller arrow-heads were of crystal, agate, green, yellow, or horn-coloured flint, and were perfect gems of colour and workmanship, and these were all found at one spot. Unfortunately, most of the finest specimens, which had been packed separately for security, were lost on his homeward journey—"a severe blow," Mr. Hudson says, "which hurt me more than the wound I had received on the knee."

Although this volume cannot have the same absorbing interest for the naturalist as the author's previous work, it is yet full of suggestive observations and reflections, and gives us a vivid picture of both animate and inanimate nature in one of the least known portions of the southern hemisphere. The volume is nicely got up, and is illustrated with a number of landscapes and figures of men and animals in the same style as in the author's former work.

Alfred R. Wallace.

OUR BOOK SHELF.

Ueber das Verhalten des Pollens und die Befruchtungsvorgänge bei den Gymnospermen. Von Eduard Strasburger. (Jena: Gustav Fischer, 1892.)

This forms the fourth part of Prof. Strasburger's "Histologische Beiträge," and it is largely taken up with an examination of segmentation in pollen-grains of the gymnosperms, and the contents of, and processes in, the pollen-tubes. Recent discoveries had led Strasburger to doubt the correctness of his former interpretation of the contents of the pollen-tubes, and his further researches have "confirmed in a surprising manner" the results obtained by Belajeff in his paper on *Taxus baccata*, entitled "Zur Lehre von den Pollenschläuchen der Gymnospermen." Strasburger is also essentially in accord with Belajeff's generalisations therefrom. Two double plates illustrate division in the pollen-grain, the development of the pollen-tube, and the further processes of fertilisation in various gymnosperms, including *Taxus*, *Pinus*, *Ginkgo*, and *Welwitschia*. An unusual condition is shown of cell-division in a pollen-grain of *Ginkgo*. Usually two or three "prothallium cells" are formed, and in part disappear before the protrusion of the pollen-tube

and the division of the "generative cell"; but occasionally they persist somewhat longer, and Strasburger figures a pollen-grain in which the three prothallium cells are intact, and the first of them has a partition at right-angles to the walls of the other cells. In this work Strasburger also gives the results of some experiments on the colour-reactions of the male and female nuclei. Rosen discovered that, as in animals, the male nucleus of phanerogams is kyanophilous and the female nucleus erythrophilous. Strasburger found that the small nuclei of the cells formed in the pollen grains of gymnosperms were kyanophilous, whether the cells were vegetative or destined for generation; but the nucleus of the pollen-tube was more or less decidedly erythrophilous. The second and larger portion of this "Beitrag" is devoted to swarmspores, gametes, vegetable spermatozoids, and the nature of fertilisation. W. B. H.

Autres Mondes. By Amédée Guillemin. (Paris: Georges Carré, 1892.)

WHETHER the author of this small volume thought that the sequence of the subjects dealt with was really quite unimportant, or whether no order at all was intended, puzzled me considerably when glancing through these pages for the first time. To be suddenly led off without a word of warning into "L'infini dans le temps et dans l'espace," and then to be as suddenly pulled back again to a second chapter dealing with Sirius seems rather a large oscillation to commence with. The same remarks might apply to the next chapters, for they treat consecutively of "The Cluster in Hercules," "Structure of the Visible Universe," "Movement in the Universe," and "The Nebula of Orion," followed up by chapters on "The Age of Stars," and "The End of the Solar System."

That the work is written by M. Guillemin is quite sufficient guarantee that strict accuracy is throughout adhered to. The book is one that can be picked up at odd moments and a chapter or two read with delight. The illustrations are excellent copies of lunar and stellar photographs taken by the brothers Henry at the Paris Observatory. W. J. L.

Some Lectures by the late Sir George E. Paget, K.C.B., F.R.S. Edited, with Memoir, by Charles E. Paget. (Cambridge: Macmillan and Bowes, 1893.)

THIS volume will be cordially welcomed by the late Sir George Paget's friends; and members of the medical profession, whether they knew him personally or not, will find in it much that cannot fail to interest them. The lectures deal with three subjects—the ætiology of typhoid fever, alcohol as a cause of disease, and mental causes of bodily disease. In dealing with each of these topics, the author presents the results of prolonged and most careful observation; and it is impossible not to admire the directness, lucidity, and vigour with which his facts and conclusions are set forth. The memoir, by the editor, is a short and attractive record of Sir George Paget's distinguished career, and its value is increased by the fact that it is accompanied by an excellent portrait.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Origin of Lake Basins.

WE may all thank Mr. Alfred Wallace for putting together so concisely the main arguments on which the glacial theory of the origin of all lake basins has had a wide acceptance. My time is just now so occupied with "earth movements" of another kind that I am unable to marshal all the arguments on the other side. But I shall try to put the main points as clearly as I can.

I accept Mr. Wallace's correction of the word "grinding" as the best word to describe the action of glaciers. It is better than either "digging up" or "scooping." Many men who account for marine gravels on such places as Moel Trefan mountain-top by the action of glaciers, *must* conceive of glaciers as capable of digging out and lifting up. But I agree with Mr. Wallace that "grinding" down is the best expression for true glacier action. This is the *mode* of action; but what of the *cause* of the motion which effects the grinding? Are we agreed on this? Mr. Wallace does not explain his view on this point. I hold that the only cause of true glacier action is gravitation, and that masses of ice will not move at all, or exert any grinding action, except when impelled by gravity down gradients more or less steep. Even if they do mount up some slopes, it is only when they are violently pushed by other masses moving down slopes from behind them. If this be true, then glaciers will not tend to dig holes out of the flat bottoms of valleys. Mr. Wallace says they will, if they are exceptionally thick. This is very doubtful: and still more is it doubtful that they can dig holes of a very peculiar character, such as is now proved to be the character of Como and other lakes, with steep and sharp outlines, or with barriers left untouched. One single fact of this kind, if well ascertained, is quite enough to upset a great theory, because it may be sufficient to prove that at least *some* lake basins *cannot* have been made by glaciers. And if some have not, it is not certain that any have been made by glaciers alone.

The constant association of lake basins with glaciated countries is Mr. Wallace's grand argument. But it is explicable in the theory of earth movements quite as easily as on the theory of glacial action. Glaciated countries are generally hilly, or mountainous. If Mr. Wallace believes that all hills and valleys are due to superficial *sculpturing alone*, of course his argument is facilitated. But if hills and valleys are even in any measure due to earth movements—crumplings of the surface—then the formation of lake basins is an inevitable necessity. Every hollow must become a lake basin which has no natural outlet except at a higher level than at its own bottom. Yet if there be such a thing as earth movements at all, it is in the highest degree improbable that they should have failed in numerous cases to occasion hollows in which water would accumulate.

Mr. Wallace's unbelief that any earth movements have taken place so lately in geological time as the glacial age—say 100,000 years ago—is a declaration that does indeed astonish me. I can understand great doubt and difficulty as to the extent of these movements. But that they have taken place to some extent very lately indeed is, in my opinion, demonstrable in the country in which I now write. There is one old sea beach on the Island of Jura where the stones as left by the surf are as bare of vegetation and as unaltered in forms which show surf action, as if the ocean had beat upon it last year. And this sea beach extends for miles at elevations varying from 120 to (I believe) 160 feet. If I am not mistaken, recent surveys of the great Canadian and American lakes have proved that they lie in hollows of crumpled and distorted land surfaces. The whole of Mr. Wallace's theory on this subject seems to me to be out of date. The distribution of boulders in the Highlands can, in my opinion, be accounted for in no other way than the transport of masses of stone on floating ice. But putting aside altogether this larger question, if a "great submergence," as one of the latest events in the glacial epoch, smaller elevations of the land are among the most certain of geological facts. But if so, we have lake-basins in all hilly countries easily explained. Very often the elevation of land to a very small extent indeed, if unequal, as it is sure to be more or less, would immediately cause lakes wherever a pre-existing valley had its lower end more tilted than its upper end. The 120 feet which is represented on the coast of Jura in this county is an elevation which would fill half of our glens all over the county with lakes unless it was an elevation perfectly equal along the whole of pre-existing contours. The co-existence of lake-basins with hilly and glaciated countries, therefore, admits of an easy explanation without attributing to ice a kind of action which has never been proved to exist at all. Hilly countries are *crumpled* countries, and slight increases or decreases of the same action must of necessity produce lakes.

Glaciers have, however, without doubt caused lakes in cases where they have dammed up the mouth of glens with detrital matter. The enormous masses of such matter which dam up the waters of the northern Italian lakes are most impressive. But it does not follow that the glaciers which left those great masses also scooped out the deep bed and rocky walls of the Lake of Como.

My own belief is that the great recency of large earth movements is one of the facts of geological science which has yet to be accepted; and that the slowness with which it has made progress, or has even been overborne, is entirely due to very natural preconceptions and general assumptions about the stability of the earth surfaces, such as those which find expression in Mr. Wallace's very interesting and significant paper.

ARGYLL.

Inveraray, Argyllshire, March 11.

P.S.—Recent calculations in America seem to bring down the possible date of the close of the glacial epoch there to little more than 10,000 years.

The Cause of the Sexual Differences of Colour in Eclectus.

Mr. F. E. Beddard says in his suggestive work on "Animal Coloration" (1892, p. 3):—

"Sometimes differently coloured animals have in reality the same skin pigments. The attention of the reader will be directed in a later chapter to the remarkable difference in colour between the males and females of certain parrots. In *Eclectus polychlorus* this sexual dimorphism is extremely marked. It would be an exceedingly anomalous fact if the same species of bird were to possess different pigments in the two sexes; and as a matter of fact it is not so in this parrot, different in colour though the two sexes are. The same pigments are present, *but the structure of the feathers is different, and thus the resulting colour as seen by the eye is different.*"

The last sentence (the italics are mine) is not consistent with late Dr. Krukenberg's investigations on the colours of feathers. The case is not one of structural difference in the feathers, for the differences in colour between male and female of *Eclectus* are occasioned by the presence or absence of the pigment itself. The green colour of the male results from a yellow pigment (*psittacofulvin*) lying over a blackish brown one (*fuscin*), but the blue colour of the female (*E. linnei*, auct.) simply results from the absence of the yellow pigment. The dark pigment (*fuscin*) is present and the incident rays of light are reflected from it, passing through a zone without pigment, which zone absorbs the rays of the red extremity of the spectrum. Here the same conditions occur which effect the blue colour of the sky. The blue is an optical colour, as is the green, but a different structure of the feathers does not come into question. The red colour both in male and female is effected by a red pigment, which is the same in both sexes, the differences in shade (as also the violet in *E. grandis*, *e.g.*) depend on the quantity of this colouring substance and in the absence or presence in different quantities of the underlying *fuscin*. The pigment of the yellow feathers in the female of *E. grandis* is the same as the yellow pigment in the green males. Dr. Krukenberg supposes that these different pigments are derived from one and the same ground substance, a supposition which appears to be very plausible.

Why the yellow pigment of the male is not developed in the blue parts of the female we do not know, nor why the different pigments in *Eclectus* are disposed just as they are, since we are in general quite ignorant about the causes of the disposition of colours in bird feathers; but in the case under discussion a "different structure" of the feathers would not give as sufficient an explanation of the facts as does the above. Touching the *causa movens* of the different colours in the sexes of *Eclectus*, we can only say that it is sexuality, but this, of course, is no mechanical explanation, *i.e.* no true explanation at all. We can only say that in most birds the male offers an *overplus* of colour as compared with the female, which *overplus* no doubt has a relation to the more vigorous biological processes or superabundant vitality in the male during certain periods, and this also holds good in *Eclectus*, as we see that the female wants the yellow pigment which the male possesses. But we must bear in mind that in *Eclectus* the young ones from the egg display already these sexual differences of colour, a fact which is as remarkable as it is rare.

For reference see C. Fr. W. Krukenberg, "Die Farbstoffe der Federn," four papers in *Vergl. phys. Studien*, 1881 sq., and my papers, *Mitth. orn. Ver. Vienna*, 1881, p. 83, and *Sitz. ber. Akad. Wiss. Berlin*, 1882, p. 517 sq.

Dresden, March 8. A. B. Meyer.

Blind Animals in Caves.

Mr. Cunningham's notion as to what constitutes "a fact" would appear from his letter published in your issue of March 9 to be peculiar. It is of course only through inadvertence that he declares a mere supposition to be a fact, and states that I have "overlooked" it. His words are "he (Prof. Lankester) has overlooked the fact that blind cave-animals are born or hatched at the present day with well developed eyes." Further on he proceeds to state that no such fact is known or recorded, but that he is "quite confident" that the young of blind cave-animals have well developed eyes.

I am quite aware that an important test of the truth of my theory of the origin of blind cave-animals would be found in the details of their embryonic development, but cannot think that Mr. Cunningham is justified either in his confidence as to the result of a hitherto unattempted embryological research or in asserting what is at variance with his own subsequent avowal, viz. that there are facts ascertained as to the condition in which blind cave-animals are born, which I have ignored.

E. Ray Lankester.

Lunar "Volcanoes" and Lava Lakes.

I have waited some time to see what replies might be made to Mr. J. B. Hannay's suggestion, that lunar walled plains may have been due to tides in the molten nucleus during crust formation (Nature, vol. xlvii. p. 7).

There seem to be at least two objections to the "volcanic" theory of lunar surfacing. First, that there must have been during the earlier, and indeed later, stages of it a vast gaseous and vaporous envelope, which, as secular temperature slowly declined, would be condensed to form seas, giving rise to a long era of erosion, and extensive denudation, and formation of sedimentary strata, as on our earth. There are no traces of this on our moon, the surfacing of which is conspicuously destitute of evidences of drainage phenomena. Secondly, there is an entire absence of distinct local colour in the detail, which should be easily seen in volcanic deposits unencumbered by vegetation and weathering.

I leave it to geologists and physicists to say if they think it at all likely or possible for any globe like our moon to pass from the semi-incandescent, lava-crusted stage, with huge vaporous envelope, to the cold, airless, and waterless condition of our satellite without passing through a very prolonged era of erosion, which, as in our case, would obliterate all traces of the former era.

Judging by our vast series of stratified rocks, we are led to conclude that an exceedingly long temperate era of erosion must, in the very nature of things, supervene on the heated lava stage in all planetary development, quite obliterating the relics of the volcanic era and relaying a sedimentary surfacing.

Taking up the second objection, *in re* the marked absence of colour, I would point out the abnormal brightness, or even brilliancy, of the lunar cliffs and steep inclines all over the surface. It is precisely at such places that astronomers expect to see the nature of the surface and degradation due to the effect of gravitation, *i.e.* where (exposed to unmitigated solar heat in the day, and a cold probably below − 100° C. at night) the cliff-falls would be most frequent, and the true colour of the strata most visible.

Proctor in his "Moon" (pp. 301-2) says:—"In each lunation the moon's surface undergoes changes of temperature which should suffice to disintegrate large portions of her surface, and, with time, to crumble her loftiest mountains into shapeless heaps. In the long lunar night of fourteen days a cold far exceeding the intensest ever produced in terrestrial experiments must exist over the whole unilluminated hemisphere."

Neison, on page 113 of his "Moon," also says:—"That physical changes of various characters must be still occurring upon the moon is rendered certain by . . . the alternate heating and cooling of the lunar strata; from the nature of the expansion and contraction thus brought into play must, through numerous fractures of the resulting general disintegration, gradually ruin all the lunar formations." Thus "considerable changes must

slowly be effected in the condition of the surface through earth-falls and landslips" . . "until all the more striking and abrupt irregularities have disappeared from their action."

Now it is precisely at cliff faces and steep slopes that we should best see the real colour, if any, of the superficial strata, and what do we find? Wherever we turn, from pole to pole, there is an entire absence of colour; they are white and at times as brilliant as "new fallen snow." If we scan the vast cliffs of the "Apennines," say at sunset, for hundreds of miles, rising to 8000 or 10,000 feet, with peaks up to 20,000, they are white, seen in sunshine.

If we examine the cliffs of the Sinus Iridium highlands, the huge array round Mare Crisium, or indeed anywhere else, it is the same, and without a doubt it demonstrates to us that the outer strata on the moon are of *the same white material all over the globe*. Precisely where degradation is most certain, and where the true colour of the strata would be distinctly visible, there we find the most extraordinary and invariable whiteness for a thickness of at least two or three miles.

A remarkable feature of the case is that, as a rule, all cliffs are much whiter than the general surface around them. In the raised ramparts of craters and walled plains, it is well known that the outer, and more gradual slopes, are invariably darker than the steep inner cliffs facing the enclosure. In Aristarchus, Theophilus, and such like rings, at sunrise, this is very conspicuous, especially in photographs, and it is not easy to account for this peculiar feature (evidently the result of disintegration and removal of the surface by gravitation) except by the supposition that the outer surface all over (and excepting rays and nimbi) is snow stained by meteoric dust. "It is well known that the fall of meteoric dust on our earth is very considerable, and estimated by Dr. Kleiberg, of St. Petersburg, at about 11,435 tons per annum. It has been found on all our ocean bottoms, and on our polar snows, where it is soon overlaid or removed by winds. On the moon, however (where there is no wind and now no snowfall), it could accumulate for many thousands of years, at least on levels, and so stain them very perceptibly."

Undoubtedly we see the true colour of the surface layers at the cliff faces, but unless the outer surface were stained in some way their bright *contrast* would be impossible.

Hence I take it that the outer layer of the surface all over, for at least one or two miles in thickness, is formed of snow, stained outside by a deposit of meteoric dust, the accumulation of many thousands of years, the removal of which, by gravitation, at cliffs causes their brightness, and this would explain the perennial enigma of where all the water has gone.

At low temperature neither ice nor snow vaporise, even *in vacuo*, and also that at low temperature ice is a non-viscous solid (like glass) has been experimentally demonstrated by Mr. T. Andrews, F.R.S., and the results laid before the Royal Society (see NATURE, vol. xlii. p. 214). The prevailing whiteness, therefore, of the lunar cliffs and steep inclines would seem to be a powerful argument against a "volcanic" surfacing to our satellite, and a good one in favour of glaciation.

The question of maximum surface temperature under fourteen days' solar heat has undergone a startling change since Lord Rosse's classical experiment. The possibility of snow existing on the moon is now admitted by leading astronomers, since the researches of Profs. S. P. Langley and F. W. Very, of the Allegheny Observatory, have demonstrated that the maximum may be so low that the *mean* temperature may possibly be below $-100°C$.

The old volcanic "selenology" is dying; there is no hope of any more *progress* in it (and that is the great sign of life in all branches of science nowadays); it is fossilised. That a "new selenology" is badly wanted is pretty obvious to all who look into the question. The surfacing of our own satellite, one of the most conspicuous and easily seen objects in the heavens, is still the standing enigma.

S. E. PEAL.

Sibsagar, Asam, February 8.

THE CROONIAN LECTURE.

MUCH interest has been excited not only among men of science but among the general public by Prof. Virchow's visit to England. From the moment when it was announced that he had agreed to deliver the Croonian Lecture, it was universally felt that it would not do to lose so good an opportunity of doing honour to an illustrious investigator. Prof. Virchow is known, of course, chiefly as a pathologist. He is the founder of the science of pathology in the sense in which it is now everywhere understood and taught; and it would be difficult to form too high an estimate of the value of this part of his labours. But Prof. Virchow is one of those men of genius who never find in any one department of research a sufficient outlet for their energies. In archæology, anthropology, and ethnology he has been for many years one of the foremost workers of the age, and he has brilliantly represented science in the political life of Prussia and the German Empire and in the municipal life of Berlin. As a teacher in the Berlin University, of which he is now Rector Magnificus, he has done much to foster a genuinely scientific spirit among the pupils who have flocked to his class-room; and as a writer he has command of so pure and attractive a style that he has been able to exercise a wholesome and stimulating influence on the intellectual life even of classes to whom science does not usually make a very strong appeal. Altogether, Prof. Virchow's career is one of which Germany has good reason to be proud. In him she possesses one of those rare and potent thinkers who touch no subject without giving it fresh significance, and who have the secret of awakening in other minds something of their own enthusiasm, independence, and vigour.

There was so great a demand for tickets that arrangements had to be made for the delivery of the Croonian Lecture in the theatre of the University of London; and here—on Thursday, March 16—a crowded audience listened with the deepest interest to what Prof. Virchow had to say about the great subject in the development of which his researches have marked so splendid an era. In the evening a public dinner was given in his honour at the Hôtel Métropole. Lord Kelvin presided, while the Presidents of the Royal Colleges of Physicians and Surgeons acted as vice-chairmen. In proposing the toast of the evening, Lord Kelvin said he was one of those who had listened with rapt attention that day to the lecture delivered by Prof. Virchow. The mystery he dealt with remained a mystery, but they were conscious of no feeling of disappointment. Though it was not for any man to tell them what life was, they had been brought nearer than ever to the solution of that fascinating problem by the researches of Prof. Virchow. Mr. Huxley, Sir James Paget, and Sir Andrew Clark also spoke of Prof. Virchow's magnificent discoveries. Prof. Virchow, in responding to the toast, expressed the pleasure he felt in being welcomed by "so large and so illustrious an assembly of the learned men of England." "Abroad," he said, "he had never seen anything like it." English men of science do not often indulge in demonstrations of this kind, and it is satisfactory to know that when they do try to show what they think of a great investigator their achievement does not fall short of anything done with a like intention in Paris or Berlin.

This week Prof. Virchow has been in Cambridge, where he has been received with as much enthusiasm as in London. On Tuesday the University marked its sense of the importance of his labours by conferring on him the honorary degree of Doctor in Science. The following is the speech delivered by the Public Orator, Dr. Sandys, in presenting Prof. Virchow for the degree:—

Dignissime domine, domine Procancellarie, et tota Academia:—

Universitatis Berolinensis Rector Magnificus, vir non modo de medicina et salute publica, sed etiam de anthropologia, de ethnologia, de archaeologia praeclare meritus, vir et sexagesimo

et septuagesimo exacto aetatis anno honoribus amplissimis cumulatus, satis magnum hodie praebet dicendi argumentum. Ipse laude nostra maior, laudes tamen suas (qua est modestia) invitus audiet; atqui laudes illas non verba nostra qualiacumque, sed ipsius opera insignia, ipsius discipuli illustres, ipsius denique orationes disertissimae, etiam ipso invito, satis clare loquuntur.

Legistis fortasse orationem illam in qua, Rectoris munus nuper auspicatus, studiorum Academicorum orbe universo lustrato, partium liberalium dux et signifer olim insignis dixit veram Academiae libertatem esse libertatem docendi, libertatem discendi; ostenditque, qua potissimum mentis disciplina iuventus Academica discendi amore vere liberali imbui posse videretur. Legistis certe, fortasse etiam audivistis, orationem alteram in qua nuperrime inter scientias biologicas locum pathologiae proprium vindicavit, et, studiorum suorum origines repetens, non modo HARVEII nostri merita immortalia denuo commemoravit, sed etiam GLISSONII nostri gloriam prope intermortuam ab integro renovavit. HARVEII quidem in doctrina, *omne vivum ex ovo* nasci, lacunam magnam relictam esse constat; laetamur lacunam tantam ab eo magna ex parte esse expletam qui primus omnium re vera probavit *omnem cellulam e cellula* generari.

Ergo rerum naturae investigator tantus, tot illustrium praesertim medicorum in Academia, titulo nostro honorifico iure optimo decoratur. Etenim ubicumque florent medicinae studia cum rerum naturae observatione exquisita feliciter coniuncta, talium virorum nomina in honore maximo non immerito habentur. Talium certe virorum per labores verba illa vetera vera facta sunt, quae Salutis in templo supra portam inscripta esse debent:—*sine rerum naturae cognitione trunca et debilis est medicina.*

Duco ad vos Regiae Societatis Londinensis unum e sociis extraneis, virum gentis Teutonicae inter decora numeratum, RUDOLFUM VIRCHOW.

The following is Prof. Virchow's Croonian Lecture:—

It is now nearly ten years since this illustrious Society conferred on me the unexpected honour of electing me one of its Foreign Members. Not this only, but last autumn it held me worthy of a further honour, in awarding me the Copley medal —a sign of the highest recognition of my work, the significance of which far exceeds the distinctions which the changing favour of political powers is accustomed to bestow. Nevertheless, deeply as I appreciated this mark of its constant and increasing esteem, still I was not in a position to offer my thanks personally to the society. Numerous duties, official and private, the weight of which has increased with each year, compelled me to continuous work at home, and even during the vacations the freedom of my movements has been for some time past restricted by international engagements, which yearly become more numerous and more pressing.

With great indulgence, which I fully know how to appreciate, the Council ha allowed me to postpone the date of my appearance in your midst. Hence, you see me only to-day among you, and I may tell you in person how very grateful I am to this Society, and how great an incentive to new efforts your recognition has become to me.

Who of us is not in need of friendly encouragement in the changing events of life? True! happiness is not based on the appreciation of others, but on the consciousness of one's own honest labour. How otherwise should we hold our ground in the midst of the turmoil of the day? How should we preserve the hope of progress and of final victory against the attacks of opponents and the insults which are spared to no one who comes before the public? He who during a long and busy life is exposed to public opinion, certainly learns to bear unjust criticism with equanimity, but this comes only through the confidence that our cause is the best, and that some day it must triumph. Such is our hope in our wrestlings for progress in science and art. Such is our hope in our struggles for civil and religious liberty, and in this hope we gradually become hardened against malicious attacks. It is a kind of immunisation which, I acknowledge, has also great drawbacks, for this hardening against unjust attacks leads very easily to a similar indifference towards just attacks, and, owing to the tendency to contradiction rooted in the nature of human thought, it finally leads also to indifference to praise and recognition. One withdraws again and again into oneself discontented with the world and with oneself also; but who can so completely retire within himself that the consciousness of the insufficiency of human thought, and that the criticisms of opponents are justified, cannot break through the crust of even the most hardened self-consciousness? Happy is he who has courage enough to keep up or regain his connections with other men, and to take part in the common work! Thrice happy he who does not lack in this work the flattering commendation of esteemed colleagues!

Such were the thoughts which filled my mind, as, looking forward to the present occasion, I reviewed my own life and the history of science, or, to use another expression, the fortunes of our predecessors. How often have I found myself in a state of despondency, with a feeling of depression! And the history of science—what long periods of stagnation and numerous interruptions has it not experienced owing to the victory of erroneous doctrines! What has saved me is the habit of work, which has not forsaken me even in the days of outward misfortune—that habit of scientific work which has always appeared to me as a recreation, even after wearying and useless efforts in political, social, and religious matters.

That which has saved science is identically the same; it only appears to be different, because the co-operation of many is necessary to secure the advance of science; hence, the exalting and consoling thought that one nation after the other comes to the front to take its share in the work. When the star of science becomes dim in one nation, it rises sooner or later to yet brighter glory in another, and thus one nation after another becomes the teacher of the world.

No science, more often than medicine, has gone through these waxings and wanings of brilliancy; for medicine alone, of all the sciences, has, for more than 2000 years, found ever new homes in the course of a progress which, though often disturbed, has never been wholly arrested.

It would lead us too far to illustrate this with examples drawn from the entire past. It is enough for my present purpose to take the outlines of modern medicine as the object of our consideration. Such a sketch, cursory as it must be, ought at the same time to throw some light on the intellectual relations of both nations, English and German, for these have taken a prominent part in establishing the principles of modern medicine.

The downfall of the old medicine, the so-called humoral pathology was brought about in the beginning of the 16th century. We, in Germany, are inclined to attribute to our nation a decisive *rôle* in this memorable struggle.

It was a man of our race, Andreas Vesalius, or from Wesel, who transformed anatomy into an exact science, and who thus, at one stroke, created for medicine a solid foundation, which it has retained ever since and, let us hope, will never again lose.

But the principal blow to the old medicine was struck by his somewhat elder contemporary Paracelsus, that charlatan, yet gifted physician, who removed from among the beliefs of mankind the doctrine of the four humores, which, *quasi*-chemical in its construction, formed the basis of the old pathology. Strangely enough he accomplished this with weapons borrowed from the armoury of the Arabs, the successors of the Greeks, and the chief representatives of the mediæval humoral pathology. From them, also, he borrowed alchemy, and, at the same time, the fantastic spiritualism of the East, which found a clear expression in his doctrine of the "Archæus," as the determining force in all living beings.

In this way, the new medicine, at its very birth, absorbed the germs of that ruinous contradiction, which, even up to this present century, has kept up the embittered strife of the schools.

To Vesalius is due the exact tendency, which starts from the observation of actual conditions, and which, without going further, we may call the anatomical.

Paracelsus, who pronounced the anatomy of the dead body to be useless, and sought for the basis of life as the highest goal of knowledge, demanded "contemplation" before all else; and, just as he himself arrived in this way at the metaphysical construction of the archæi, so he unchained among his followers a wild and absolutely fruitless mysticism.

Nevertheless there lay hidden in that "contemplation" of his a healthy kernel, which would not allow the intellectual activity which it had stirred up to come to rest. It was the idea of *life* which formed the ultimate problem for all future research. Strangely enough, this idea, which always existed in the popular mind, and which is in an unmistakable form present even amongst primitive nations, had been driven far into the background in scholastic medicine. Ever since the time of Hippocrates it had been the custom to use, instead

of life, the obscure expression φύσις, *natura*; but in vain does one seek for a more exact definition of the term. To Paracelsus nature was living, and the basis of his life was that very "archæus," a force differing from matter, and separable from it, or, as he himself expressed it, in the sense of the Arabs, a spirit, "spiritus." In the compound organism of man, the mikrokosmos, each part, according to him, had its own "archæus," but the whole was ruled by the "archæus maximus," the "spiritus rector." From this premiss has proceeded the long succession of vitalistic schools, which, in ever-changing forms, and with ever new nomenclature, introduced into the notions of physicians this idea of a fundamental principle of life.

If the sagacious Georg Ernest Stahl, whose services to the development of chemistry are now acknowledged everywhere, substituted the soul for the "spiritus rector," and so created a system of animism, the last vestiges of which have disappeared from the school of Montpellier within our own time only, so also in turn did the pure vitalists build up on the dogma of specific dynamic energies, maintained so stoutly by the physicists, that notion of the vital force, the half spiritualistic and half physical character of which has contributed so much, even in our day, to puzzle and mislead men's minds.

The doctrine of the vital force found its strongest support in the "Natur-philosophie," especially in that which, on German ground, soon obtained universal sovereignty.

This summary exposition of mine has greatly anticipated the historical progress of the evolution of medicine. It is now time to pay proper homage to the great investigator who made the more exact method the ruling one, and at the same time to award to this country, which brought him forth, its important share in determining the new direction of our science.

Nearly 100 years had passed since Vesalius and Paracelsus had begun their work when William Harvey published his "Exercitatio anatomica de motu cordis et sanguinis in animalibus." Here, for the first time, the anatomical examination of living parts was carried through, in an exemplary way, according to experimental methods. All the objections that anatomy concerned itself with dead parts only were thus at once set aside; living action became the object of immediate observation, and this was done on one of the most important organs, one absolutely necessary to life, the varying activity of which constantly calls for the attention of the practical physician. Not only so, however, but a new mode of observation—the experimental method—was thus brought into use for research; a method through which a new branch of medical science, physiology, has been laboriously built up.

The influence of this one wonderful discovery of Harvey's on the ideas of men of his time, and of his successors, was memorable.

Among the men of his time the last support of Galenism disappeared with the proof of circulation; among his successors the comprehension of the causation of local processes dawned for the first time. Very ancient and highly difficult problems, such as inflammation, could now be attacked; a goodly piece of life also became intelligible, since one of the vital organs themselves could now be subjected to experiment, and, to the astonishment of all, the action of this organ showed itself to be an absolutely mechanical one. The revulsion of thought was so complete that it has become since a difficulty hardly to be overcome to enter even in imagination into the ideas of the older physicians, to whom the circulation of the blood was unknown.

Nevertheless, in spite of such striking results, the craving of man for more complete understanding remained unsatisfied. One saw the action of the living heart, but how did it live? What was this life, the action of which one saw before one? In the heart itself the essence of life could not be recognised.

Harvey turned his attention to another object; he tried to observe the very beginnings of life in the incubated egg of the fowl and in the embryos of mammalian animals. He thereby soon arrived at the question of the significance of the egg in general, and enunciated the celebrated dictum, "Omne vivum ex ovo." Owing to the more extensive researches of modern investigators, this dictum, as is well known, proved too narrow for the whole animal kingdom, and is no longer exact when applied to plant life. Its validity for the higher animals, on the other hand, cannot be questioned, and it has formed one of the firm standpoints on which researches on sexuality and on the propagation of life have been based. But Harvey, on account of the deficiency of his optical instruments, was unable to see that which he was labouring to discover, namely, the process of organisation as such, just as he had been unable in former times to see the continuity of the capillary flow. This imperfection lasted for a long time afterwards; and thus it happened that even Albrecht von Haller and John Hunter considered the formation of the area vasculosa in the incubated egg of the fowl as the commencement of organisation, and indeed, as the type of organisation itself.

I will return to this point later on; but for the present I should like first to draw your attention to a man whose importance for the further development of the doctrine of life has always appeared to me to have been uncommonly great and highly significant, but who, nevertheless, has sunk into unmerited oblivion, not only among posterity in general, but also, I think I may be allowed to say, even in the memory of his countrymen. I mean Francis Glisson, who was a contemporary of Harvey, and whose works appeared almost simultaneously with those of his more celebrated colleague; but the brilliancy of Harvey's discoveries was so great that the light which shone from Glisson's work-table almost disappeared. I rejoice that on so auspicious an occasion I may recall the memory of the modest investigator, and may offer him the tribute of gratitude which science has to award him.

When, thirty-five years ago, I published my little essay on "Irritation and Irritability" (*Archiv für Pathologische Anatomie und Physiologie*, 1858, vol. xiv. p. 1), I did not know much more about Glisson than what every student of medicine learns, namely, that there is in the liver a "capsula communis Glissonii," and what was even less known, that this anatomist had written a small work on "Rachitis," which, indeed, was the first of its kind. In my own paper on this disease (*ibid.* 1853, vol. v. p. 410) I had tried to demonstrate the circumspection and accuracy which are noticeable in this book, and which make it a typical model for all collective investigations; but even at that time I overlooked the fact that this was only the smallest merit of this wonderful man. It was only in the further course of my studies on the history of the doctrine of irritation and irritability that I made the discovery, an astonishing one to me, that the idea of irritability did not, as is generally thought, originate with Haller, but that the father of modern physiology, and the Leyden school in which he had been brought up, had borrowed this idea from Glisson. I then stumbled on a series of almost forgotten publications of this original scholar, especially his "Tractatus de natura substantiæ energeticæ seu de vita naturæ ejusque tribus primis facultatibus, perceptiva, appetitiva et motiva," which appeared in London in 1672, and in which the ideas were further worked out, the outlines of which had already been brought forward in his "Anatomia hepatis," published in 1654. In this work (p. 400) the newly-coined word "irritabilitas" appears, so far as I can find out, for the first time in literature. It may be noticed, by the way, that the expression "irritatio" is much older. I find it already in Celsus, but with an exclusively pathological signification. It appears, also, occasionally in later writers, and to this day it has not, speaking accurately, lost this original signification. It is otherwise with Glisson; to him, irritability is a physiological property, and irritation merely a process of life dependent on the natural faculties of living matter.

Thus he was led, through a process of "contemplation," to maintain the existence of the "biarchia," the "principium vitæ," or the "biusia," the "vita substantialis vel vitæ substantia." And in order to allow of no misunderstanding as to the scource of his "contemplation," he adds distinctly that this is the "archæus," of Van Helmont—the "vis plastica" of plants and animals.

In the further course of his philosophical discussions, he nevertheless is led into the same by-path, which has misled, even in the most recent times, so many learned men and even excellent observers. This is the by-path of unlimited generalisation. The human mind is only too prone to render intelligible what is unintelligible in particular phenomena, by generalising them. Just as even in recent times an attempt has been made to render consciousness intelligible by representing it merely as a general property of matter; so Glisson thought he might attribute to the active principle ("principium energeticum") which according to him is contained in all matter the three faculties of living matter which he considered as fundamental, namely, the facultas perceptiva, appetitiva et motiva. All matter was sensitive, was thus stimulated to develop impulses, and moved itself as a consequence of these impulses.

It is not necessary for the purpose of our present inquiry to carry these quotations further, since they are quite, in the Paracelsian sense, contemplative in their nature; and especially as, in their generalisation, they do not appear to be important for the history of advancing knowledge.

That which is full of significance for us is concerned with actual life only, in the narrower sense of analytic science. It was not the "principium energeticum" set up by Glisson, which stimulated his successors again to take up the thread of his observations, but rather this process of irritation described by him, and the fundamental faculties of living matter on which it depended. In this way he has really led up to a more exact study of the actions of life and the properties of living matter.

Unfortunately, there intervened a mistaken conception, which led his followers again into a series of most serious errors. Glisson, following on this point also the example of Van Helmont, was convinced that nerves contracted when irritated. He joined to this the idea that, through the contraction of the nerves, or even of the brain, the fluid contained in them was propelled towards the periphery.

This notion, shared by Willis and many other physicians of that time, furnishes the reason why irritability was identified with contractility. Even the great master Hermann Boerhaave, and after him his pupil Gaubius, the first special writer on general pathology, considered sensation and motion as common properties of, at all events, all the solid parts of the body. The former thought it proved that hardly a single particle of the body existed which was not sensitive and did not move; and thus it becomes comprehensible how Haller himself carried this idea that irritability had the same significance as contractility from his school days in Leyden to his professorship in Göttingen. It was in this sense that he understood the irritability of the muscles, and in the same sense he denied this property to the nerves.

This dispute about the irritability of muscles has continued far into the present century; its long duration becomes intelligible only when we bear in mind that, without the most exact knowledge of its historical development, even the very statement of the question is liable to be misunderstood.

As a matter of fact, so far as we know, the nerves are not contractile, like the muscles; on the other hand, the muscles are not only contractile, but are also irritable. Irritability and contractility are not identical, even when they occur in the same part. The nerve current, on the other hand, cannot be compared with the blood stream; it does not consist in the movement of a fluid, but is of electrical nature, and hence there is no need for its production of a contraction of the nerve-tubes.

It was also an erroneous conclusion that every irritated part contracted. Instead of contraction, secretion, or, under certain circumstances, a more vigorous nutrition, may occur as the final result of irritation. Hence we use a more comprehensive term in order to express this final result, and call all forms of it "actions." While Glisson defined all "actio propria sic dicta" as "motus activus," we distinguish different kinds according to the nature of the effects, or, expressed otherwise, according to the direction of the activity (nutrition, formation, and function): but we agree with the above thinker in the opinion that no vital energy is ever set free without stimulus: that, therefore, every action is of an irritative nature. In this irritation, according to my idea, consists the "principium dividendi," according to which we must distinguish between active and passive processes of life, and in this way we gain also a basis for the fundamental division of pathological elementary processes. How much work has been necessary in order to render this conception possible! And how great, even now, is the number of our colleagues who have not fully accepted it! The reason for this difficulty is two-fold.

Most of the vital actions of life, whenever they manifest themselves by visible events, are of a compound nature. As a rule very various, at times wholly unlike parts, each with its specific energy, combine to produce them. Not unfrequently it thereby happens that in the visible sum of final effects one part behaves in an active the other in a passive manner. It is only the most minute analysis of the phenomenon, tracing it right back to the elementary parts, which allows the total result to be resolved into its components; such an analysis cannot, for the most part, be expressed in current language, except at great length. No language in the world is rich enough to possess special expressions for each such combination. Only too often we help ourselves out of the difficulty by regarding the compound phenomenon as a simple one, and by expressing its character according to some chief trait, which stands out in a commanding manner from the general picture. This is the practical difficulty.

With it, however, a theoretical difficulty is very often combined. The human mind, owing to a natural impulse, seeks in the phenomena indications of their determining cause. The more complex the phenomenon the more busy is the imagination, in order to convert it into a simple one, and to find a unitarian cause for it. So has it happened in respect to life, so in respect to disease. The course of thought followed by Glisson is opposed to such an explanation. He had no scruple in dividing the unit of life into a large number of individual lives. Although the knowledge we now possess of the arrangements of the body was absolutely foreign to him, yet he arrived quite logically at the "vita propria," the proper elementary life, of the several parts. To be sure, this expression, as far as I can see, is not to be found in his works, and occurs first in those of Gaubius; but Glisson says distinctly ("Anatomia hepatis," "Ad lectorem," N. 17): "Quod vivit per se vivit vitam a nulla creatura præter se ipsum dependentem. Hoc enim verba vivere per se sonant."

The unitarian efforts of the following period relentlessly passed over the tendency of which I have just spoken. Some returned to the old Mosaic dictum, "the life of the body is in his blood"; others gave the nervous system, and the brain especially, the first place in their consideration. Thus once more was renewed the old struggle, which for thousands of years had divided the schools of medicine into humoral and solidar pathology. Even when we ourselves entered on scientific work, hæmato-pathologists stood in hostile attitude to neuro-pathologists.

In England, humoral pathology found a strong support in the great and legitimate authority of John Hunter. Although this distinguished practitioner never shared the one-sidedness of the later pathologists, but rather attributed to the solid parts the living principle the existence of which he assumed, yet, in his investigations, the blood took precedence over all other parts as the chief vehicle of life.

One must, however, recall to mind that Hunter laid special stress on the fact that life and organisation are not bound to each other, since animal substances which are not organised can possess life. He started, as has already been noticed, from the erroneous conception that eggs are not organised, and that it was not till after incubation that the first act of organisation, namely, the formation of vessels, took place. He considered his "diffuse matter" ("materia vitæ diffusa") as the actual carrier of life; and this was to be met with not only in the solid parts, but in the blood also. This matter, according to him, existed in the brain in a remarkable degree of concentration, but its presence was quite independent of all nervous structures, as is shown by the example of the lower animals which possess no nerves. In the posthumous writings of Hunter, which Owen has collected, the very striking expression "simple life" is met with, a state most clearly to be recognised in plants and the lowest animals. This simple life was in Hunter's view the ultimate source of all living actions, pathological as well as physiological.

Hunter was out and out a vitalist, but his materialistic vitalism, so to speak, differed *toto cælo* from the dynamic vitalism of the German schools. If living matter existed independently of all organisation, such living matter was beyond the scope of anatomical investigation; but, on the other hand, if it were present in non-organised parts, such as an egg, it was in itself the ultimate source of the organisation which subsequently makes its appearance in these parts. It must, therefore, to adopt a later mode of expression, be of a plastic nature. Here Hunter's notion fell in with that of the plastic lymph, as developed by Hewson; and it was only logical that Schultzenstein applied it to the blood at last, and designated as "plasma" the material of life present in the blood. In this way the formative and nutritive matter necessary to physiological life as well as the plastic exudations occurring in diseased conditions could be attributed to the same material—a highly satisfactory result in appearance, and one providing a most convenient basis for interpretations. The exponents of this notion had no scruples in going one step further, and in providing this material of life with a technical name. They called it "fibrin." Evidently this did not quite correspond with Hunter's ideas, for we know of no such matter, either in the egg or in the plants or the lower animals, as that to which he attributed simple life; but the necessities of pathology

overcame all such scruples, and the plastic exudations were received as undoubted evidence that fibrin possessed the power of becoming organised. They formed, in the *crasis* doctrine of the Vienna school, the bright spot of this newest kind of hæmatopathology.

Wherever fibrin failed, blastemata were brought to the fore. Ever since Schwann had given the name of cytoblastema to the organising material of the egg, the way had been open for assuming in other places the existence of material with this ambiguous name.

But of course through these steps the one simple matter of life predicated by Hunter was replaced by many "matters of life," and thus the entire advantage gained by the exposition of a unitary theory of life was at once lost.

Even when, finally, the cell-contents were designated as protoplasm, and thus the one requisite of Hunter, namely, that the material of life must also be contained in the individual parts, appeared to be fulfilled, yet no single specific material was thereby arrived at. No one dreamed of regarding protoplasm as fibrin, and least of all did any one consider it a simple chemical body.

By the conception of the blastema, however, there had been reawakened a thought which had occupied the minds of man from the earliest times. If a plastic matter capable of being organised really existed in the body, then the organisation of the same must present the first reliable example of epigenesis. The problem of the "generatio æquivoca," which had been fought over for so long a time, now appeared to be solved. What Harvey had taught concerning the continuous descent from the egg became temporarily obliterated, when the theory of descent through exudation made its appearance. Several generations of young medical men have been educated in this belief. I myself remember my "epigenetic" youth, with no little regret, and I have had hard work to force my way through to the recognition of the sober truth.

Meanwhile, the attention of other bodies of inquirers had been directed to the tissues of the body. Among these, in view of their importance, the nervous tissues, and especially the mass of nervous tissues in the brain and spinal cord, rank highest.

Hunter also had acknowledged the importance of the brain, and hence called it the "materia vitæ coacervata." It was easily seen that it contained no fibrin, but experimental research showed also that neither the brain nor the spinal cord was of the same value throughout all its parts. The more accurate the experiments the smaller became the region which, in the strictest sense, is the vital part, until Flourens limited it to one single spot, the knot of life ("nœud vital"). Was the unity of life found in this way? By no means. The brain is no more and no less vital than the heart; for life is present in the egg long before the brain and heart are formed, and all plants, together with an immense number of animals, possess neither the one nor the other. In the highly compound organism of man, the brain and spinal cord have a certain determining action on other parts necessary to life. Their disturbance may immediately be followed by the disturbance of other vital organs, and sudden death may ensue.

But the collective death of a compound animal no more implies the immediate local death of all its special parts than the local death of some of the latter is incompatible with the continued collective life of the animal. As has been well said, at the death of a compound organism there is a "primum moriens," one part which first ceases to live; then follow, at long intervals sometimes, the other organs, one after the other, up to the "ultimum moriens." Hours and days may pass between the total death of the individual and the local death of the parts. The fewer nerves a part contains the more slowly usually does it die; I therefore consider the process of dying in the compound organism as the best illustration of the individual life of the several constituent parts, which is in its turn the first axioma necessary for the study and for the understanding of life.

A long time, however, elapsed before it was possible to return to this starting point, and to obtain a considerable number of supporters for the doctrine of the "vita propria." The attention of many observers was drawn to a totally different side of the question. In the last decade of the past century, about the same time that John Hunter, starting from careful anatomical investigations and exact observations of surgical practice, worked out his idea of the material of life, a new system of medicine was founded in Scotland, the so-called Brownian system, which was based on quite different premisses. Brown also was a vitalist; he, too, constructed, not merely a pathological and therapeutic system of vitalism, but a physiological one, though this doctrine was dynamic in its character. There is but little to be noticed therein of the material anatomical foundation of exact medicine. It is concerned principally with contemplations of the forces of the living organism. One can understand to some extent how this happened, if one keeps in view the histo.y of the development of this extraordinary personality; I cannot go into this here, but anyhow the remarkable fact remains that the two contemporaries, Brown and Hunter, worked near each other without its appearing from their writings that they were acquainted with one another. Brown struck out his own line, and stuck to it, without troubling himself about the rest of the medical world. And yet even his first work "Elementa Medicinæ," had the effect of an earthquake; the whole European continent was shaken by it, and even the physicians of the recently opened New World bent under the yoke of revolutionary ideas; and in a few years the aspect of the whole field of medicine was entirely changed. True! the triumph was but short; the Brownian system disappeared as it had come, a meteor in the starry heaven of science. There would be no reason to go into it more fully, had not the impulse which he had given instigated other men, and be permanently applied by them to the true service of science. This impulse was founded on the fact that irritability, or, as Brown called it, "incitability," was thus reinstated as the starting point of the theory; but, along with this, the stimuli which set living substances in action, the "potestates incitantes," were brought to the fore. In so far that stimuli produce a state of irritation ("incitatio"), or, as Brown called it later, excitement, they came to be viewed not only as the cause of health and disease, but even of life itself; for excitement, so he said, is the true cause of life. But, as excitement stands in a certain relation to the strength of the stimulus, a state of good health was only possible with a normal degree of stimulus, whilst an excess or a lack of stimulus brought diseased conditions in its wake. Of course excitement is dependent also on irritability, with a certain quantity of which, in the form of energy, every living being is endowed at the beginning of its life.

The division of diseases, according to the amount of vital force visible in them, into sthenic and asthenic, has never been abandoned since, though acknowledged perhaps in a less precise manner; it has sometimes been brought more prominently forward, and sometimes thrown into the background. In Germany, Schönlein was the one of all others who took this doctrine as the foundation of his opinion on special cases of disease, and for his choice of treatment.

But the application of the Brownian principles to physiology has been of far greater importance. If life itself were dependent on external stimuli, the notion of the spontaneity of vital actions, a notion still in force, must lose all significance. Certain stimuli would in that case prove to be necessary conditions of vital activity, without which life could at best be carried on in a latent form only. Certainly even for this latent life the question remained open: How does it come to pass, and in what does it practically consist? Brown avoided this ticklish question, not without great skill, by drawing the whole attention to active life and to the stimuli which call forth action. To speak openly, science has since then deflected little, or not at all, from this guiding notion. Even now, we cannot say what latent life is. We simply know that through external stimuli it may be converted into active life, and hence irritability is considered by us as the surest sign of life, not of course of the general life of all matter in the sense of Glisson, but of the real and individual life of special living organisms. Brown remarked, with reason, that through irritability the living substance is differentiated from the same substance in its dead condition, or from any other lifeless matter. Nevertheless, neither irritability nor incitability, neither irritation nor incitation, explains the essence of the living substance, and therefore neither explains the essence of life.

In Germany the physiologists especially took up this question. Among the first was Alexander von Humboldt, who in his various writings, especially in his celebrated treatise on the irritated muscle and nerve fibre, entered into the question. In the end he held fast to the assumption of a vital force. The majority of pathologists and physicians followed in his footsteps, and long and fierce controversies were necessary before, nearly half a century later, the belief in a vital force was destroyed. When du Bois-Reymond had demonstrated the electrical current

in muscle and nerve in all its characters, and, at the end of his work, had also disclosed the inadmissibility of vital force, then the venerable Humboldt formally and expressly renounced the dream of his youth, with the masterly submission of the true naturalist to the recognised natural law.

The hypotheses of a particular force of life had, however, in regard to Brown's theory neither a positive nor a negative value. Johannes Müller rescued for general physiology, in which it has ever since kept its place, that which was valuable in Brown's system, the doctrine of the integrating life stimuli. The occasional stimuli which produce disease have found their place in etiology; their significance has become more and more sharply defined, the more accurately we have learnt to distinguish between the causes and the essences of disease, a distinction which became more difficult as the "causæ vivæ" of diseases became known in ever-increasing numbers. And now a new task has arisen, namely, to draw into our sphere of observation the life of the causative agents themselves.

The way in which pathology has tried to approach the desired goal, to fathom the living substance in its diseased conditions, has led us a great step forward. Pathological anatomy, especially, has opened this road. The more numerous its observations, and the more it penetrated into the details of the lesions, the smaller became the field of so-called general diseases. The first steps of mediæval anatomists had the effect of drawing the attention to local diseases. In the first and longest period, which one may define as that of Regionism, the pathological anatomists sought the cause of disease in one of the larger regions or cavities of the body—in the head, chest, or abdomen. In the second period, ushered in by the immortal work of Morgagni, shortly before the time of which I last spoke—the time of Brown and Hunter—they endeavoured to find in a certain region the actual organ which might be considered as the seat of disease. On this foundation arose the Parisian school of Organicism, which, until late in this century, held a dominant position in pathology. In this school, already, they recognised that not the organ, nor even a portion of it, could be the ultimate object of research. Xavier Bichat divided the organs into tissues, and showed that in the same organ sometimes one and sometimes another tissue might be the seat of disease.

From that time forward the eye of the pathological anatomist was directed chiefly to the changes in the tissues, but it soon became apparent that even the tissues are not simple substances. Since the third decade of this century, the microscope has disclosed the existence of cells, first in plants, and very soon afterwards in animals. Only living beings contain cells, and vegetable and animal cells show so much similarity of structure that one can demonstrate in them the actual product of organisation. This conviction has become general, since through our embryologists, especially through Schwann, proof has been afforded that the construction of embryonic tissues was derived from cells also in the highest animals and in man himself.

In the fourth decade of this century the science of pathological anatomy had already begun to be directed towards cells. These researches very soon struck on great difficulties. Many tissues, even in their developed state, appeared to contain neither cells nor their equivalents; nevertheless, I have been able to demonstrate their existence in those tissues in which their presence appeared to be most doubtful, viz. in bone and connective tissues. At the present time we are so far advanced as to be able to say that every living tissue contains cellular elements. We go a step further even, for we require that no tissue should be called living in which the constant occurrence of cells cannot be shown.

A still greater difficulty then appeared, namely, to discover in what way new cells originated. The answer to this question had been very heavily prejudiced by the so-called cell-theory of Schwann. Inasmuch as this very trustworthy investigator asserted that new cells originated from unformed matter, from "cyto-blastema," there was opened up a wide road to the old doctrine of the "generatio æquivoca," which afforded all partisans of plastic materials an easy way of reviving their dogma. The discovery of cells of connective and allied tissues gave me the first possibility of finding a cellular matrix for many new growths. One observation followed another, and I was soon in a position to give utterance to the dictum, "Omnis cellula a cellula."

And so at last the great gap was closed which Harvey's ovistic theory had left in the history of new growth, or, to speak more generally, in the history of animal organisation. The begetting of a new cell from a previous cell supplements the reproduction of one individual from another, of the child from the mother. The law of the continuity of animal development is therefore identical with the law of heredity, and this I now was able to apply to the whole field of pathological new formation. I blocked for ever the last loophole of the opponents, the doctrine of specific pathological cells, by showing that even diseased life produced no cells for which types and ancestors were not forthcoming in normal life.

These are the fundamental principles of cellular pathology. In proportion as they have become more certain, and more generally recognised, they have in turn become the basis of physiological thought. The cell is not only the seat and vehicle of disease, but also the seat and carrier of individual life; in it resides the "vita propria." It possesses the property of irritability, and the changes in its substance, provided these do not destroy life, produce local disease.

Disease presupposes life; should the cell die, its disease also comes to an end. Certainly, as a consequence, the neighbouring and even far distant cells may become diseased, but as regards the cell itself the susceptibility to disease is extinguished with life.

Since the cellular constitution of plants and animals has been proved, and since cells have become recognised as the essentially living elements, the new science of biology has sprung up. It has not brought us the solution of the ultimate riddle of life, but it has provided concrete, material, anatomical objects for investigation, the structures and active and passive properties of which we can analyse. It has put an end to the wild confusion of fantastic and arbitrary notions such as I have just mentioned; it has placed in a strong light the immeasurable importance of anatomy, even in the most delicate conditions of the body; and lastly, it has made us aware of the close similarity of life in the highest and lowest organisms, and has thus afforded us invaluable means for comparative investigation.

Pathology has also its place, and one certainly not without honour, in this science of biology, for to pathology we are indebted for the knowledge that the opposition between healthy and diseased life is not to be sought in a fundamental difference of the two lives, not in an alteration of the essence, but only in an alteration of the conditions.

Pathology has been released from the anomalous and isolated position which it had occupied for thousands of years. By applying its revelations not only to diseases of man, but also to those of animals, even the smallest and lowest, and to those of plants, it in the best manner helps to strengthen biological knowledge, and to narrow still more that region of the unknown which still surrounds the intimate structure of living matter. It is no longer merely applied physiology; it has become physiology itself.

Nothing has more contributed thereto than the constant scientific union which has endured for more than 300 years between English and German investigators, and to which we to-day add yet another link. May this union never be broken!

APPLIED NATURAL HISTORY.

THE so-called experimental sciences—chemistry and physics—in their various branches, have hitherto been more extensively "applied" to the service of man, than the observational sciences of botany and zoology.

The various industries in which civilised man has naturally become engaged have induced a scientific study of the fundamental principles, and an eager search for such information as can lead, with the assistance of art, to a further advance towards the goal of perfection.

It is true, however, that the practice of medicine has much dependence on the science of botany.

Zoology, on the other hand, has never been considered as possessed of qualities serviceable to any bread-winning occupation, and although included, like botany, in all ordinary courses of medical study, has not until recently been considered of importance for the advancement of any industry.

Now, when the nineteenth century is in its last decade, we in this country are beginning to realise that a knowledge of the life-histories and habits of sea-fishes and

other food-products of the deep is of paramount importance in regulating and bettering the fisheries around our coasts.

A few years ago the scientific aspects of this industry received but scant attention. Many outcries have indeed been always heard as to injurious methods of fishing, the wilful destruction of fish suitable for food, and the general depletion of certain fisheries, but in spite of Royal Commissions and Courts of Inquiry, we have been slow to grasp the truth that for want of proper knowledge with which to control our laws and regulations we have been timidly procrastinating, and allowing our chance of ready resuscitation to diminish. We have about 400,000 men dependent on our fisheries, and yet are at the present day lagging behind other and younger countries in our State Aid. In Scotland the proportion between fishermen and the rest of the population is 1 in every 76; in Ireland 1 in every 216; in England and Wales 1 in every 612. In a recent report of the Board of Trade it is also stated that "the sea fisheries of the United Kingdom appear to be of greater value than those of any other country in which fishery records are kept." The value of the fish landed annually in the United Kingdom is about six million pounds, and yet a large proportion of our fishermen eke out a miserable existence, and see the industry in which they are engaged becoming more and more unremunerative every year. In Scotland, where most is done for our fisheries, there is a Government Board where appeal can at all times be made by any persons desiring alterations in the existing state of circumstances. A Board which not only collects all statistics, but which has power and capabilities to inquire into all methods of fishing, whether from a biological or commercial standpoint, as well as to construct by-laws if necessary. In England the absence of such a body is much felt. Conference after conference is held, but although promoted under the most favourable auspices, the resolutions agreed upon can hardly be made to impress the House of Commons, because of this want of a proper channel. It would be quite out of place in an article such as the present to speculate as to the constitution of a Fishery Board for England, but without any doubt it should have not only a representative of biology, but a small staff of investigators.

The unfortunate antithesis which at present exists between so-called practical people and men of science results largely from the unknown altitude from which the latter choose somewhat exclusively to illuminate the world. Without desiring in any way to discount the pursuit of knowledge for its own sake, it seems apparent that the benefits to be derived for our fisheries are not to be obtained from the lovers of pure science, but rather from those who, having had the proper scientific training, are willing to occupy a position in which they will be intimately acquainted with the requirements of practice as their object, and yet be able to focus the theoretic rays of the specialists on the different sections of their work.

The history of the various Royal Commissions has thrown considerable light on the particular nature of the information needed. It has also shown how widely the investigations yet to be carried on must extend.

Take, for example, the old vexed question of beam-trawling in Scotland. Fishermen practising the time-honoured art of long-lineing appeared as witnesses before the Commission of 1883, and being keenly antagonistic to the trawler, described how this species of robber descended upon their old haunts, scraped and harrowed the bottom to the utter destruction of all spawn and fry, scooped up tons of fish (which should have lived to have been caught by hook and line in the proper manner), and glutted the market with what was quite unfit for human food.

It is often extremely difficult to separate political interests from fishery reports, but the fact remains that evidence of this kind, being inserted in the public press, led to much misunderstanding, and inclined people to support the line fishermen at the expense of the trawler. But the late Lord Dalhousie, as chairman of the Commission, was fortunate in having as one of his colleagues a naturalist who had for many years given special attention to fisheries. The statements, therefore, as to destruction of spawn and young fish were tried and found wanting. The evidence as to the natural history of fishes being most wild and conjectural, though given by men who had spent their lives at sea and were masters of their craft, was met by scientific accuracy and fell to the ground. We find in the official report of the Commission, published in 1886, very decided statements indicating that in the opinion of the Commissioners the injury done by the use of the beam-trawl is insignificant.

Much information has now been gained as to the eggs and embryology of sea fishes, and important observations published on such matters; for instance, as to the proportional numbers and sizes of the sexes, and the sizes at which the various food fishes become sexually mature.

Observations made on the last-named inquiry show that on different coasts where the conditions of life vary as to temperature, food, or ocean currents, the sizes at which any individual members of a species of fish spawn are distinctly different, and that the rate of growth is different. This is a matter of some importance to those who would prevent capture of fish till after some progeny has been allowed to remain. Fulton's experiments on the proportional numbers of the sexes show that out of 12,666 fish of twenty-one species examined, 3,858 were males and 8,808 were females—a ratio of 228 females to 100 males.

The flounder and the brill were, however, found to be exceptions, while the greatest inequality was found in the case of the long rough dab (*Hippoglossoides limandoides*), where the ratio was 842 females to 100 males, or nearly seventeen females to every two males. As regards the proportional size, the observations show that "Among all the flat fishes without exception, the female is longer than the male, the ratio varying with the species."

Mr. Holt, who has worked most extensively at the sexual maturation of fishes, in order to determine if possible a method of protecting fishes which have never spawned, discards the male sex altogether, and considers only the sizes of the females, since the males, being both smaller and less numerous, would be more highly protected than the females by any measures drawn up with a view to prohibiting the capture or sale of flat fishes under certain sizes. Others who have worked at the same subject pursue the same course.

These inquiries have been instituted not for their own sakes, but because, from studying the fisheries of the country, it has become obvious that knowledge of this kind is essential. The constant clamour kept up by fishermen who daily see their returns becoming smaller does not reach the ears of those who are busily occupied in commerce, or in science; it is appreciated only when special attention is paid to the history and present condition of some of the most important areas. Take the great industry of the Dogger Banks, which for other reasons has come before the notice of the public of late years. In 1828 the North Sea was practically an unknown fishing region. Boats of no very great size were in that year just beginning operations from Harwich. Before this date trawling was confined to the south coast, having commenced at Brixham about the year 1764. The Dogger Bank was found to be teeming with fish; there was plenty for every one, and an almost endless scope for fresh ventures. The "Silver Pits" were discovered in 1837, the name being significant of the value to the discoverer and his followers. So things went on, more and larger boats were built, heavier gear used, boats banded

together in fleets, and remained out on the grounds for weeks at a time, steam was introduced, and the east-side of the North Sea visited. It was a "roaring trade," and many were made wealthy by it. Now things are changed, and every one cries out that the balance has been overturned, that the fish are being caught faster than the stock is being kept up: this, in spite of what was once said as to the amount of fish which could be taken from one acre of sea-bottom. It is possible to fix close times during which salmon and trout must not be taken from certain rivers, and to hatch fry which will remain in the one district. It is another matter to apply close seasons, or fix standard sizes for areas of the open sea. From what we know of life at the sea-bottom it is pretty certain that if one of the conditions necessary for keeping up a true balance of nature is removed or greatly lessened, the proportional arrangement of the remaining fauna is also interfered with, for since marine animals prey largely upon each other it follows that if one class of devourers is removed, the devoured become more numerous, which again seriously affects other classes.

For this reason an over-fished oyster or mussel bed if left to itself, or not properly regulated, will probably never regain its former condition, a fact brought out with great clearness in the course of the evidence taken before Lord Balfour of Burleigh, at the Board of Trade Conference last June. With free swimming round fish the condition is somewhat analogous, although more knowledge is required concerning their migratory movements. If the natural balance is interfered with, the result, although at first it may be only to increase certain other forms which are also of advantage to man, will eventually appear when useless or unprofitable fishes remain in the majority, or when the appearance of a once common and useful species is no longer present in the market.

If human interference can so alter the marketable productivity of the sea, and materially lessen the incomes of a large portion of a nation, surely it becomes a duty to study the application of such sciences as deal directly with the animals concerned. If by continual fishing the only available grounds became depleted, it is by a thorough study of the actual cause and effect, and the application of the principles of natural history involved, that the only true remedy is to be found.

W. L. CALDERWOOD.

THE SOUTH KENSINGTON LABORATORIES AND RAILWAY.

THE friends of science throughout the country may be congratulated upon the fact that work in the laboratories of the Royal College of Science and of the City and Guilds Institute is not to be rendered impossible by the building of a railway along Exhibition Road. Sir John Kennaway, the chairman, and the members of the House of Commons Committee deserve the best thanks of the community for their unanimous rejection of the scheme even if only partly on scientific grounds. When the evidence given before the committee comes to be published there will be some curious reading. Lord Kelvin, the President of the Royal Society, informed the committee of what was at stake, and gave his opinion as to the question both of mechanical and electrical disturbance. The paid "scientific experts" in their pleading on the side of the company promoters may be said to have almost eclipsed the usual "emphasis" of statement. We may refer to this evidence later, but in the meantime the following quotation from a leader in the *Times* indicates the general opinion as to the importance of the result which has been achieved:—

"What makes the history of this Bill novel and interesting is the second line of attack adopted by its opponents. On either side of Exhibition Road stand two of the most important scientific institutions in London. One of these—the Royal College of Science—is supported by the State; the other was founded by the City and Guilds of London for the promotion of advanced technical education. The former of these institutions, and the great collection of scientific instruments which is being formed at South Kensington, make an organised whole. This collection, which includes the earlier and the latest instruments, is invaluable both historically and practically; and is in close proximity to the lecture-halls and laboratories where use can be made of the instruments. The collection and the laboratories are used not only by many other students, but by the large number of national scholars and exhibitioners who, after the annual May examination of the Science and Art Department, are brought up from all parts of the country, chiefly at the public expense. These students, and the deserving lads who work at the City and Guilds Institute, form an important element in the situation; for to them the advent of an electrical railway was a serious peril. It was shown, and admitted, that the magnetic disturbances in the neighbourhood of the South London Railway are so great that no accurate magnetic work can be done within some hundreds of yards of it. Now the proposed Paddington and Clapham Railway would run, not some hundreds of yards from the South Kensington laboratories, but within forty feet of some of them; and there was a genuine fear on the part of the Professors that at such small distances it would be impossible not only to accurately neutralise the conflicting forces, but to prevent the astronomical instruments being affected by the earth-tremors caused by the passage of trains. This view was urged by Lord Kelvin, perhaps the greatest living authority on such matters, and by Profs. Norman Lockyer, Ayrton, Rücker, and Boys; and after a contest which lasted three days their view prevailed, and the committee found the preamble of the Bill 'Not proved.' The men of science are to be congratulated on the result. A year or more ago they successfully defended their South Kensington preserve against the invasion of Art; and it would be pitiful indeed if Science were now to be put in jeopardy by a practical application of herself. It appears that electricity cannot be studied in the neighbourhood of an electric railway; naturally, then, we cannot have an electric railway close to the great central institution where electrical science is taught at the public expense."

NOTES.

THE annual general meeting of the Institution of Naval Architects is being held this week in the rooms of the Society of Arts, which have been lent for the purpose. The proceedings began yesterday (Wednesday) morning, and will conclude to-morrow evening. The meeting is one of more than usual importance in the history of the Institution from the fact that the president, the Earl of Ravensworth, is resigning the position which he has so well filled for a period of fourteen years Lord Ravensworth is the second president the Institution has had, he having succeeded to the chair on the death of Lord Hampton, who first occupied the position. The new president is Lord Brassey, whose great interest in all maritime questions well qualifies him for the post. Lord Ravensworth will not sever his connection with the Institution, as he will accept the position of a vice-president. The following is the programme of the present meeting:—Wednesday, March 22.—Morning meeting, at twelve o'clock: Annual report of Council; address by the president (the Earl of Ravensworth); on the present position of the cruiser in warfare, by Rear-Admiral S. Long; on approximate curves of stability, by W. Hök. Thursday, March 23.—Morning meeting, at twelve o'clock: Some considerations relating to the strength of bulkheads, by Dr. F. Elgar; on the measurement of wake currents, by George A. Calvert; on the new Afonasieff's formulæ for solving approximately various problems connected with the propulsion of ships, by Captain E. E. Goulaeff. Evening meeting, at seven o'clock: Some experiments on the transmission of heat through tube-plates, by A. J. Durston; some notes on the testing of boilers, by J. T. Milton. Friday, March 24.—Morning meeting, at twelve o'clock: On an apparatus for measuring and registering the vibrations of steamers, by Herr E. Otto Schlick; on the re-

pairs of injuries to the hulls of vessels by collisions, stranding, and explosions, by Captain J. Kiddle. Evening meeting, at seven o'clock: Some experiments with the engines of the s.s. *Iveagh*, by John Inglis; on the cyclogram, or clock-face diagram, of the sequence of pressures in multi-cylinder engines, by F. Edwards; presentation of an address from the Institution to the Right Hon. the Earl of Ravensworth, on his retirement from the office of president. In addition to the above there is a paper by Lord Brassey on merchant ships as cruisers. The annual dinner was held at the Holborn Restaurant yesterday evening. In summer the Institution will meet at Cardiff.

ON Friday a deputation will wait upon Mr. Campbell Bannerman to make some representations as to the position of those Woolwich cadets who have taken up science at the entrance examination. The existing system at the Royal Military Academy, as we have repeatedly taken occasion to point out, is very unfavourable to cadets of the scientific type, and it is hoped that the approaching interview may lead to the adoption of more reasonable methods. Among the members of the deputation will be Sir Henry Roscoe, Sir Henry Howorth, and the head masters of Rugby, Cheltenham, and Clifton.

MR. W. L. CALDERWOOD has resigned the post of director of the Laboratory of the Marine Biological Association at Plymouth. He vacates the residence early in April.

WE are privately informed of the death, on the 7th instant, of Dr. G. Vasey, the chief of the botanical section of the United States Department of Agriculture at Washington. He was a native of Yorkshire, we believe, and emigrated to America many years ago. The grasses of North America were his special study, and he published several important works on this family. The "Grasses of the Pacific Slope" and the "Grasses of the South-west," fully illustrated, are his latest works; but the former is not yet completed. Dr. Vasey wrote also on the agricultural value of the grasses of the United States. Last year he visited England, and made many friends through his amiable disposition.

WE learn with regret, from the daily papers, that the Rev. W. Woolls, of Burwood, near Sydney, New South Wales, has lately died. It is stated that he emigrated from England as long ago as 1831, and he certainly did much to promote science in the country of his adoption. Botany was his favourite study, and he made several important contributions to botanical literature, chiefly on the botany of New South Wales. He was president of the "Cumberland Mutual Improvement Society," and in that capacity delivered a number of carefully compiled instructive lectures on the vegetable products and resources of the colony, and other branches of botany. One of the most interesting of his published lectures is on the progress of botanical discovery in Australia, which is indeed a concise and correct history of the subject. It was he who wrote the appreciative reviews of the volumes of Bentham's "Flora Australiensis" that appeared in the *Sydney Morning Herald*, and he himself published separate accounts of the plants of the neighbourhood of Sydney, of the Paramatta district, and of the colony of New South Wales.

THE *Botanisches Centralblatt* announces the death of Dr. Karl Prantl, Professor of Botany in the University of Breslau, and director of the Botanic Garden there. For some years past Dr. Prantl has edited *Hedwigia*, a journal devoted to cryptogamic botany; but it was chiefly as a teacher that he was known. An English edition of his "Lehrbuch der Botanik" was edited by Dr. S. H. Vines in 1880.

THE following are among the lecture arrangements at the Royal Institution after Easter:—Mr. John Macdonell, three lectures on symbolism in ceremonies, customs, and art; Prof. Dewar, five lectures on the atmosphere; Mr. R. Bowdler Sharpe, four lectures on the geographical distribution of birds; Mr. James Swinburne, three lectures on some applications of electricity to chemistry (the Tyndall lectures). The Friday evening meetings will be resumed on April 14, when a discourse will be given by Sir William H. Flower, on seals; succeeding discourses will probably be given by Prof. A. B. W. Kennedy, Prof. Francis Gotch, Mr. Shelford Bidwell, the Right Hon. Lord Kelvin, Mr. Alfred Austin, Mr. Beerbohm Tree, Prof. Osborne Reynolds, Prof. T. E. Thorpe, and other gentlemen.

DR. H. WOODWARD, F.R.S., is the president of the Malacological Society which was founded lately at a meeting held at 67, Chancery Lane. The Society will meet at the same place on Friday, April 14, at 8 p.m., and again on the second Fridays in May and June, after which there will be no meeting till November.

ANY one who may desire to learn all that is best worth knowing about the progress and prospects of technical education should read an admirable lecture on the subject delivered by Sir Philip Magnus last week before the Society of Arts, and printed in the current number of the Society's Journal. Sir Philip is of opinion that what is now wanted is the co-ordination of our resources and the simplification of our machinery. The Technical Instruction Committees, with the help of their able secretaries, are doing good and useful work, although much of it is necessarily impeded by the restrictions of the Acts of Parliament under which they work. Between these bodies and the School Boards, Sir Philip urges, there should be earnest cooperation. To them, acting together, and strengthened by the representatives of other educational interests, should be ultimately submitted the duty of making that further provision for secondary education, the need of which is generally admitted.

A MEETING was held at the First Avenue Hotel on Saturday last for the purpose of forming a Cage-bird Club. Dr. Martin, chairman of the Norton Ornithological Society, and vice-president of the London Cage-bird Association, occupied the chair; and a paper was read by Mr. W. H. Betts, who explained that the object of the club was the enrolment among its members of ladies and gentlemen who, from the fact that the majority of cage-bird clubs were held at public-houses, were debarred from membership thereof. He said the club would endeavour to train novices in the management of cage-birds, would give encouragement and assistance to ornithological societies generally, would circulate literature with the object of improving the moral tone of the cage-bird fancy, and would endeavour to prevent cheating at shows and to put an end to brutality. On the motion of the Rev. W. K. Suart, president of the Cage-Bird Association, seconded by Mr. George Crabb, president of the London and Provincial Ornithological Society, it was determined that the club should be founded. Mr. Betts was appointed honorary treasurer, and Miss E. A. Darbyshire honorary secretary.

DR. JAMES RORIE, writing from Westgreen House, Dundee, sends us the following note on a brilliant meteor:—"A very brilliant meteor, or fire-ball, was seen here about 6.23 p.m. on Saturday evening, the 18th inst. When first observed it was about 70° above the horizon south-south-west from the asylum, and moving in a direction from east-south-east to west-northwest. It was visible for about five seconds, and appeared like a large pale blue ball of fire throwing off jets of red-coloured flames, and leaving behind it a pale white silvery streak, marking its course across the sky like a very thin line of vapour, but at the point near the horizon where the meteor disappeared leaving a shining electric blue colour. This streak was in all probability composed of dust particles thrown off by the meteor

during the passage in a state of ignition through the atmosphere, as it remained visible for nearly three-quarters of an hour, first as a straight line, and then, evidently caught by the westerly wind, becoming gradually contorted, and, slowly expanding and disappearing, it passed overhead like a long thin twisted cloud of pale blue smoke."

During the latter part of last week the high pressure over France gave way, and several shallow secondary depressions passed across our islands, accompanied by northwesterly winds, snow and hail showers. Sharp frosts occurred in places at night, the shade minima varying from 20° to 23°, while the grass temperatures were much lower, the thermometer on Saturday night falling as low as 12° to 16° in the Midland counties and in London; but during the bright intervals of the day-time the maxima reached 50° and upwards. Towards the close of the week an anti-cyclone which previously lay off our south-west coasts spread over the United Kingdom, and extended eastwards over the continent. The weather during the next few days became fine and bright generally, with the exception of fog in the neighbourhood of London and the south-east of England. The maximum day temperatures exceeded 60° at several stations, but the nights continued exceptionally cold, the ground being thickly coated with hoar frost. Such severe frosts as those experienced on several nights during the past week rarely occur so late in the season. The *Weekly Weather Report* for the week ending the 18th instant shows that, notwithstanding the very low minimum temperatures, the averages for the week were rather above the mean in England and the south of Ireland. Rainfall was considerably in excess of the average in the north of Scotland, but less in all other parts. The greatest amount of bright sunshine was recorded in the north-east of England, where there was 52 per cent. of the possible amount; the lowest average amount was 18 per cent. in the north of Scotland.

With the view of enabling masters of vessels to know what weather to expect at sea in the far East, and to choose the best routes, all the observations recorded in the archives of the Hong Kong Observatory made between 0° and 45°, and between Singapore and 180° E. Gr. are being tabulated, and will serve for the construction of maps, which will ultimately make it possible to issue pilot charts for the China Seas. Dr. Doberck invites all persons having old log-books in their possession to send them to him on loan. There are log-books of our large lines which, if forwarded to the proper quarters, might help to make passages shorter, pleasanter, and safer.

The Societies forming the Scientific Alliance of New York have held their first joint meeting, the object being to present the needs of science in that city, and the plans and purposes of the Council of the Alliance. The addresses delivered on this occasion have now been published as a pamphlet. We may note that the membership of the societies is over 650, and is said to include the names of nearly all persons in New York who are interested in pure science.

Columbia College, New York, has received from Mr. Loubat an endowment which is to be used for the encouragement of the study of (1) The history, geography, and numismatics, (2) the archæology, ethnology, and philology of North America. It will permit an award at least every five years alternately in these two groups of subjects. This year two prizes of 1000 dollars and 400 dollars will be given for the best works published in English on the subjects in question. The author need not be a citizen of the United States. The works must have been published since January 1, 1888, and must be based on original research. Copies must be sent, not later than June 1 of the present year, to the president of Columbia College, whose secretary will furnish copies of the regulations adopted.

Mr. Thomas Steel, of Victoria, has been visiting several zoological gardens in Great Britain and America; and in the February number of the *Victorian Naturalist* he gives an interesting account of some of his experiences. In the London Zoological Gardens he was naturally attracted especially by animals and birds from Australia. The kangaroos seemed to him to have very small quarters compared with those set apart for kangaroos in the Melbourne gardens. Nevertheless, he thought them "fairly healthy and sleek." Mr. Steel was much pleased with a pair of Australian brush turkeys, who were evidently "quite at home in their enclosure." The laughing jackass, however, was the animal which interested him most strongly. He had "quite a thrill of pleasure" when he recognised its "well-remembered voice." Of the collection of animals in the Central Park, New York, Mr. Steel formed no very high opinion. He was much surprised that so mighty a city should be "so far behind in a matter of this kind." Of the "dejected-looking lions" in the Central Park he says that they were greatly to be pitied. They were "cooped up in the smallest of cages, with no proper shelter and no exercising yard."

The *Kew Bulletin*, appendix ii. 1893, consists of a list of the new garden plants of the year 1892. The list includes not only plants brought into cultivation for the first time during 1892, but the most noteworthy of those which have been reintroduced after being lost from cultivation. Other plants included in the list have been in gardens for several years, but either were not described or their names had not been authenticated until recently. These annual lists, as the *Bulletin* points out, are indispensable to the maintenance of a correct nomenclature, especially in the smaller botanical establishments in correspondence with Kew, which are, as a rule, only scantily provided with horticultural periodicals. The lists also afford information respecting new plants under cultivation at Kew, many of which will be distributed from the Royal Gardens in the regular course of exchange with other botanic establishments.

Prof. P. H. Schoute and some other Dutch mathematicians have undertaken to edit, under the auspices of the Mathematical Society of Amsterdam, a "Revue Semestrielle des Publications Mathematiques." The first part of the first volume has just been issued by W. Versluys, Amsterdam. The "Revue" appears likely to be of service to mathematicians far beyond the limits of Holland.

The Smithsonian Institution has published a collection of translations of some of the best recent memoirs issued in European countries on "The Mechanics of the Earth's Atmosphere." The work has been prepared by Mr. Cleveland Abbe, who expresses his conviction that "meteorology can be advanced beyond its present stage only by the devotion to it of the highest talent in mathematical and experimental physics.

The geological department of Colby University, U.S., has published a useful "Summary of Progress in Mineralogy and Petrography in 1892," by W. S. Bayley. The volume consists of monthly notes contributed to the *American Naturalist*.

Mr. Elliot Stock has issued a little volume, by "Medicus," showing how the height and chest measurement may be increased by systematic exercise. The title of the volume is "How to Improve the Physique."

In the current number of the *Comptes Rendus* there are two papers on the use of the electric current in producing high tem-

peratures. In one MM. Moissan and Violle describe two forms of electric furnace which they have used in their experiments. The substance to be heated is contained in a small crucible made of carbon having two holes pierced through its side to allow the carbon rods, between which the arc is formed, to pass. This crucible is surrounded by blocks of lime to reduce the loss of heat on account of radiation. In one form of furnace there is an arrangement by which a piece of graphite, after being heated in the arc, is allowed to fall into a calorimeter, and by this means they have found that a temperature of 3000° can be reached. In the other paper MM. Lagrange and Hoho have investigated the fact, observed by Planté and others, that when you pass a sufficiently strong current through an electrolyte, using as negative electrode a fine wire, and as positive electrode a conductor of considerable surface, a kind of luminous sheath is formed round the negative electrode. The authors find that the heat developed in this sheath is very great, and that by its means a very intense heat can be applied at any point of a body while, on account of the rapidity with which the heat is disengaged, the rest of the body remains cold. As an application of this method they have heated to a bright red the outside of a bar of steel, while the inside remained comparatively cool, then by merely stopping the current the cold liquid has come in contact with the hot steel. In this way they have hardened the outside of bars of steel, while the inside has remained soft and therefore tough.

PROF. L. WEBER, of Kiel, has recently constructed a mercury barometer which can be filled without boiling, and whose vacuum can be freed from residual air at any time in a few seconds. It consists, according to the *Zeitschrift für Instrumentenkunde*, of a vertical tube with two bulbs, one on each side. One of these bulbs ends in a tube to which an indiarubber tube can be attached. The other is connected by a short tube with a capillary constriction. A narrow tube connects the lower end of the bulb with the top of the main tube, thus forming a kind of double barometer. To fill it mercury is poured into the first bulb and allowed to enter the main tube. In doing so it forces the air down through the narrow tube and out by the second bulb. Some mercury also enters the latter by the capillary constriction. On placing the instrument in a vertical position a vacuum is formed at the top of the two communicating tubes, which is slightly longer in the narrow one owing to capillary depression. Barometric readings are then taken in the usual way by means of a scale fixed to the main tube. The vacuum can be tested and easily restored in the following way: The indiarubber tube attached to the first bulb ends in an elastic ball with a small hole in it. This hole is closed by the thumb and the ball is compressed. Mercury is thus forced up the main tube and over into the capillary tube. If there is any residual air it will form a bubble between the two columns, which will on further compression be driven out through the second bulb. On releasing the pressure the vacuum is re-established, and the slight difference of level in the two bulbs is gradually obliterated by the passage of mercury through the capillary contraction. The latter can be replaced by a glass rod with a conically ground end, by means of which the communication between the two bulbs can be temporarily interrupted.

AN interesting communication concerning metallic osmium is contributed to the current number of the *Comptes Rendus* by MM. Joly and Vèzes. Metallic osmium, as usually prepared by the method of Berzelius, which consists in calcining the sulphide in a carbon crucible, takes the form of a powder or a spongy mass of a blue colour. As thus obtained it is rapidly attacked by the oxygen of the air with production of the volatile and dangerously poisonous tetroxide OsO_4; hence the metal constantly exhales a strong odour due to the vapour of the tetroxide. Sainte-Claire Deville and Debray some time ago succeeded in obtaining metallic osmium in the form of beautiful little greyish blue crystals, by passing the vapour of the tetroxide through a strongly heated carbon tube. The density of these crystals, 22·48, was the highest which has been observed for the metal. All the efforts, however, of Sainte-Claire Deville and Debray to fuse osmium in the flame of the oxyhydrogen blowpipe were unavailing. If enclosed in a crucible of carbon surrounded by another of lime, the metal simply remained unchanged, but if heated directly in the flame itself it rapidly disappeared, owing to its conversion into the volatile tetroxide, but no trace of fusion was ever observed. It is now shown that osmium does melt at the temperature of a very powerful electric arc, in a manner analogous to ruthenium. It is, of course, essential that special precautions should be taken in order to prevent loss of the extremely expensive metal by oxidation, and consequently volatility, particularly as the volatile product of the oxidation, the tetroxide, is so injurious to the experimenter. The operation was therefore performed in the electric furnace devised by Ducretet and Lejeune, which enabled the metal to be heated in a carbon crucible placed in a closed chamber traversed by a stream of carbon dioxide. Under these conditions when osmium is rapidly raised to the highest temperature of the electric arc it melts without sensible loss by volatilisation. After fusion osmium presents a very brilliant metallic surface of a beautiful blue colour slightly tinged with grey. It breaks with a crystalline fracture, and is distinguished by its remarkable hardness, being harder than both ruthenium and iridium, readily cutting glass and scratching quartz. Moreover, after fusion osmium appears to be no longer attacked by the atmospheric oxygen, its surface remaining bright greyish-blue.

THE whole of the refractory metals of the platinum family have now been obtained in the liquid form. Of them all osmium has been found the most refractory, its melting point being considerably higher than that of ruthenium. It resembles the latter metal very much in many of its properties, particularly as regards the ready formation of a volatile tetroxide. It differs entirely, however, from ruthenium in aspect, exhibiting as above described a remarkable blue metallic lustre, while ruthenium is more white than platinum, resembling in fact burnished silver. The six metals of the platinum group would appear to more particularly resemble each other in pairs, ruthenium and osmium having many physical and chemical attributes in common, rhodium and iridium being similarly very nearly allied, and palladium and platinum forming the third pair. In many respects, however, osmium exhibits a peculiar and somewhat isolated character, more akin to that of the metalloidal elements; indeed, so marked is this that Deville and Debray termed it the metalloid of the platinum group, Berzelius compared it to arsenic, and Dumas to tellurium.

NOTES from the Marine Biological Station, Plymouth:—Little change has been observed in the floating fauna since last week. *Sarsia prolifera* and medusæ of *Clytia Johnstoni* have again been taken; and *Obelia* medusæ have been plentiful, although for the most part very small and immature. A few *Polydora* larvæ have been taken. *Evadne Nordmanni*, which at times is abundant in the surface waters, has made its first appearance for the year; the few individuals noticed were carrying embryos in the brood pouch. The Nemertine *Cephalothrix lineare* and the crabs *Portunus depurator* and *holsatus* have begun to breed.

THE additions to the Zoological Society's Gardens during the past week include eleven Orbicular Horned Lizards (*Phrynosoma orbiculare*) from California, presented by Mr. William Chamberlain; a Stanley Parrakeet (*Platycercus icterotis*) from Australia, deposited; a wandering Albatross (*Diomedea exulans*) captured

off Cape Horn, purchased; an Upland Goose (*Bernicla magellanica*) from the Falkland Islands, a Mute Swan (*Cygnus olor*) European, received in exchange; a Mouflon (*Ovis musimon*), four Shaw's Gerbilles (*Gerbillus shawi*), four Barbary Mice (*Mus barbarus*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE MELBOURNE OBSERVATORY.—On September 2 last Mr. Ellery, the Government Astronomer, made his annual report to the Board of Visitors to the Observatory. This report shows that with his staff a great amount of work was got through, the following being a brief summary:—With the meridian circle 3590 observations for Right Ascensions, and 2233 for N. P. D. were made, these numbers including the observations for the places of the guide stars used in the astrographic operations. The great telescope, owing to the demands on the staff for the astrographic work, has not been much in use, the routine work having been dropped altogether. It is pleasing to hear that a good start and considerable progress has been made in the part allotted to them in the photographic chart and catalogue of the heavens. Up to June 30, 278 plates had been exposed, excluding a great number obtained for purposes of testing adjustments, &c., although Mr. Ellery remarks that the weather since May was anything but inviting for such work. With the photoheliograph 201 sun pictures were obtained. The observations and records relating to terrestrial magnetism, meteorology, and intercolonial weather service, and time distribution have been continued as usual with satisfactory results. In the seventh paragraph of the report Mr. Ellery informs us of the necessity that has arisen for the reduction of expenditure. Mr. White, the chief assistant, and Mr. Moerlin, the second assistant, were both called upon to retire on September 30, having attained the age of sixty years, both a considerable loss to the observatory, having served there thirty-one and thirty years respectively, and Mr. Ellery found it necessary to close the observatory workshop, and dispense with the mechanic. In a re-organisation of the duties it will be necessary, he says, to put in abeyance observations with the great reflector, reduce meteorological work, including some photographic registration, stop ordinary extra-meridian observation, except the most important, reduce publications and issue of weather charts, and generally to limit operations to the most important and urgent kind. Such a reduction as this after so many years of smooth working and the loss of two such experienced and efficient officers must fall heavily on Mr. Ellery's shoulders, but we are glad to hear that the new scheme is now in working order. We hope to hear also that Mr. Wallace's services have been retained for the astrographic chart, as Mr. Ellery says in a supplementary report that without him this undertaking will have to be dropped.

NATAL OBSERVATORY.—Just as in his former report, Mr. Nevill, the Government Astronomer, is indebted to several ladies for assistance in the observatory, without whose aid he says the numerous astronomical and meteorological computations and reductions could not have been carried out (Report of the Government Astronomer for the year ending June 30, 1892). Again, he urges the necessity of removing the transit to another position, this instrument being so close to the equatorial that only one of them can be used at a time. Besides the usual observations for the comparison of the declinations deduced from observations made at observatories in both hemispheres, by a comparison (Talcott's method) of the zenith distances of northern stars and southern circumpolar stars, the work for determining the latitude of the observatory has been brought to a conclusion and awaits publication. The work, comparing the Greenwich lunar observations from 1851–1888 with the basis of Hansen's Lunar Tables, comprising a discussion of four thousand observations, has been completed, and auxiliary tables, founded on the corrections thus deduced, are now being formed. Several observations of Mars were made to determine the distance of the sun, and these are at present being reduced.

THE BIELIDS OF 1872, 1885, AND 1892.—In "Our Astronomical Column" on p. 451 we referred to a note by M. Bredichin on the Bielids, in which he said that from observations made last year it seemed very probable that the densest part of this swarm had undergone perturbations, amounting to a recession of the ascending node of nearly 4°, due to the proximity of the planet Jupiter. In the current number of *Astronomische Nachrichten*, 3156, he further suggests that the swarm has undergone a separation, perhaps into many parts, an analogous case of such a separation having occurred in the comet 1889 I. The force which accomplishes this division he denotes by I. at the commencement of separation and assumes that its direction coincides with the line of the radius vector, being positive and negative when directed towards and from the sun. Denoting by R the radius of the earth at the time of the meeting with the swarm, and the common radius vector, v the true anomaly of this radius in the original orbit, and v_1 that in the derived orbit; representing the angle between this common radius vector and the tangent to the original orbit by β, and with any one on the derived orbit by β_1, he educed the following values for the elements of the three orbits, where m is the value of the velocity of commencement for one second of time:—

	Comet.	I.	II.	III.
T	1859·390 G.M.T.	1872·986	1885·983	1892·976
π	109° 50′·4	108° 55′·0	108° 45′·3	108° 59′·2
☊	246 1·3	—	—	—
i	12 22·0	—	—	—
log a	0·54950	0·55149	0·54833	0·55050
log e	9·87711	9·87788	9·87668	9·87750
log q	9·94123	9·94087	9·94138	9·94103
U	6·672	6·718	6·645	6·695
log R	—	9·99395	9·99397	9·99426
log r	—	9·94216	9·94156	9·94146
v	—	+ 5° 48′·0	− 3° 34·0	+ 3° 3′·0
v_1	—	+ 6 43·4	− 2 28·9	+ 3 54·2
β	—	87 30·5	91 32·0	88 41·4
β_1	—	87 6·5	91 4·2	88 19·3
I	—	− 0·0099	− 0·0116	− 0·0095
m	—	292m.	342m.	279m.

COMET HOLMES (1892 III.).—M. Schulhof's ephemeris for this comet gives for the ensuing week:—

12h. Paris Mean Time.

1893.		R.A. (app.) h. m. s.		Decl. (app.) ° ′ ″
March 23	...	3 8 3·8	...	+35 47 40
24	...	9 52·5	...	50 28
25	...	11 41·4	...	53 16
26	...	13 30·5	...	56 3
27	...	15 19·8	...	35 58 49
28	...	17 9·3	...	36 1 34
29	...	18 58·9	...	4 10
30	...	3 20 48·7	...	36 7 2

PROF. HALE'S SOLAR PHOTOGRAPHS.—Among the latest advancements in obtaining photographs of the sun, including simultaneously the chromosphere, faculæ, spots, &c., Prof. Hale has distinguished himself especially in this direction. With regard to the method which he adopts, M. Janssen communicates to the *Comptes Rendus* for March 6 (No. 10) a few words. I ask the Academy, he says, "la permission de lui faire remarquer que le principe de cette seconde fente a été très nettement indiqué par nous dans les Communications faites à l'Académie en 1869, et, avec plus de détails, dans une Communication faite au Congrès de l'Association britannique tenu à Exeter la même année."

GEOGRAPHICAL NOTES.

THE recognition accorded to geography in the University of Cambridge is not confined to the lectureship. The subject of the English essay proposed for competition this year by members of the University is announced as "The influence exercised upon British literature by the geographical features of the country." Probably "conditions" would convey the meaning better than "features," but apart from such detail, the subject is one likely to turn the attention of competitors to a much neglected matter—the geography of their own country.

THE survey of Greece is being actively carried on by the Austrian Government surveyors, who undertook the work in 1889. The primary triangulation is already completed, and while filling in the topographical details of the provinces of Thessaly and Albania the survey officers will be accompanied

by an Austrian botanist and geologist from whose studies much new information is expected.

ONE of the interesting minor results of M. Dybowski's recent journey from the Mobangi to the Shari was the discovery that the natives of that part of the Sudan use chloride of potassium instead of chloride of sodium to season their food. They carefully select plants which on burning yield an ash containing a minimum of carbonates, and extract their "salt" by boiling water, subsequently filtering and evaporating the solution.

DR. A. GLOY has recently published a very interesting discussion of the population of Schleswig-Holstein, tracing its distribution to the character of the land. In order to represent graphically the cause and effect on the same paper, the various agglomerations of people from single cottages to towns of over 2000 inhabitants, are shown by dots of increasing size on a geological map. It thus becomes apparent that the population is arranged so that the fertile fenlands and clay ridges which run from north to south are relatively thickly peopled, while the belt of sandy and barren soil separating them has few houses except along its boundaries. The type of dwelling in rural villages is also found to vary, showing a clear relation to the former extension of the Slav tribes westward before the time of Teutonic predominance.

IN a careful study of the political divisions of the earth, Dr. A. Oppel has come to the conclusion that about 1,700,000 square miles are uninhabited or ownerless, about 5,000,000 square miles more without settled government, and the remaining 45,000,000 square miles are occupied by definite states. He recognises seventy-five such states, but most of them are of such insignificant superficial extent that the eighteen largest make up 87 per cent. of the whole area.

FLIES AND DISEASE GERMS.

AS we become more intimately acquainted with the nature of pathogenic micro-organisms, the manner in which their distribution takes place also becomes more intelligible. For several years past, through researches made by Grassi, Cattani, and Tizzoni, it has been known that flies are capable of disseminating cholera bacteria. These authors placed minute quantities of these bacilli on to the bodies of flies and found that after carefully preserving them under a glass shade in diffused daylight for an hour and a half and longer, when introduced into sterile culture media these flies gave rise to typical cholera growths. These results have quite recently been confirmed by Simmonds. Further experiments on the part played by flies in the propagation of disease germs have been made by Celli, who *fed* flies with the sputum from phthisical patients, also with pure cultivations of the typhoid bacillus, of anthrax, and other organisms. The particular microbes experimented with were afterwards demonstrated in the excreta of these flies, partly by microscopic examination and partly by direct inoculation into animals. The latter method was especially successful in the case of the anthrax and tubercle bacilli. A paper which has just appeared by Sawtschenko in the *Centralblatt für Bakteriologie*, vol. xii. p. 893 ("Die Beziehung der Fliegen zur Verbreitung der Cholera") contains an account of some experiments which the author has made on the fate of cholera bacilli when introduced into flies. The flies used in these investigations were (1) the common small house-fly and (2) a much larger variety, which, from the description given, would seem to answer to our so-called "blue-bottle fly." It was further marked by its rapid flight, its rare occurrence within doors, by feeding on all manner of decaying substances, besides being frequently found on articles of food of all kinds. These flies were placed in shallow dishes containing a few drops of broth infected with cholera bacilli, after which they were removed and fed on raw meat or sterile broth. In some cases the excrements of cholera patients were substituted for the cholera cultures. It would appear very difficult to keep flies alive in captivity, for the healthy as well as those experimented upon died in nearly all cases after twenty-four hours; in only very few instances was it possible to preserve them four days. Not only were the excreta of the flies carefully examined for cholera bacilli, but in many cases the whole contents of the abdominal cavity were removed with all the proper antiseptic precautions, and inoculated into culture tubes. This latter practice was adopted in order to satisfactorily dispose of all suggestion of the presence of cholera germs in the excreta being due to their accidental contamination from the feet of the flies themselves. In all cases cholera bacilli were found, both in the alimentary tract and in the flies' excreta. Moreover, guinea pigs inoculated with cultivations of cholera microbes obtained from the former died quite as rapidly as when inoculated with ordinary cholera cultures, thus showing that their virulence had not been impaired through residence in the fly's body. In the intestinal tract of those flies fed with cholera excreta, not only were cholera bacilli found, but also other organisms resembling the vibrio Metschnikowi Gamaleïa, and which on inoculation into guinea-pigs and pigeons killed them in twenty-four hours. Similar results were obtained when the vibrio was separated out directly from the cholera excreta and inoculated into these animals. Thus in this case also the virulence of the organism had undergone no abatement during its sojourn in the fly's alimentary tract, thus fully confirming similar results with other organisms obtained by Celli. Sometimes enormous numbers of cholera bacilli were found in the alimentary tract of flies after seventy-two hours, in spite of their having been fed after the first infection with nothing but sterile broth, with the object, if possible, of washing out the bacilli. Sawtschenko makes the alarming suggestion that the bacilli may very possibly be able, under suitable conditions of temperature and nourishment, to multiply within the bodies of flies, in which case the latter must not only be regarded as dangerous carriers of infection, but as a hot-bed for the preservation and further multiplication of cholera bacilli.

SCIENTIFIC SERIALS.

American Journal of Science, March.—The specific heat of liquid ammonia, by C. Ludeking and J. E. Starr. The liquid ammonia used in the experiments was found to contain 0·3 per cent. of moisture, and on spontaneous evaporation to leave only a trace of residue. The specific heat was measured by Regnault's method, the liquid being enclosed in a steel tube of 16·122 cc. capacity, stoppered by a steel screw. The mean value for the specific heat deduced from two series of experiments was 0·8857.—A short cycle in weather, by James P. Hall. If a diagram is drawn exhibiting the changes of daily mean temperature in New York city for a few months it will be discovered that these fluctuations occur every three or four days, on an average, but that some have much greater amplitude than others. In the course of four weeks, perhaps, there will be only two or three conspicuous rises and falls. Upon further scrutiny there will be observed a tendency in these more prominent features of the curve to repeat themselves at intervals of about 27 days. That these and kindred oscillations in New York city are, in the main, representative of temperature changes over the greater part of the United States becomes evident on comparing temperature curves taken at Utah, St. Paul, St. Louis, and New York respectively. A conspicuous rise of temperature at New York is apt to be a day or two behind that at St. Louis, fully two days behind St. Paul, and sometimes nearly a week behind Utah. Mr. Hall attempts to find a relation between this 27-day period and the sun's rotation, which takes place in about the same time.—Kilauea in August, 1892, by Frank S. Dodge. The chief object of interest on the floor of Kilauea was the lava lake of Halema'uma'u, whose surface was found to measure 12·1 acres, which is much larger than any lake in recent years. The lake is nearly circular in form, its longest diameter being 860 feet, and the shortest 800 feet. The lava was about three feet below the rim on an average. Frequent breaks occurred in the rim, from which large flows took place, in some cases covering several acres of the floor. One large flow on the night of August 25th covered about one-third of the floor, and raised its level from one to four feet. The lake was at times very active, with fountains playing over its surface in every direction, as many as fifteen being counted at one time by a careful observer. Small fountains were always to be seen in some locality, and the whole surface was marked by long irregular seams always in motion.—Also papers by Messrs. Chamberlin, Darton, Upham, and Winslow, and the Address delivered

before the American Metrological Society, December 30, 1892, by the President, Dr. B. A. Gould.

Bulletin de l'Académie Royale de Belgique, No. 1, 1893.—On Poisson's law of large numbers, by P. Mansion.—On the influence of time upon the mode of formation of the meniscus at the temperature of transformation, by P. de Heen. If a sealed glass tube is partly filled with carbonic acid in the liquid state, and then heated slightly above the critical temperature, the meniscus forming the surface of separation gradually disappears until all the liquid is converted into vapour. But for some time after this has taken place the density of the substance above the surface of separation is less than that below, as may be seen by the appearance of a generating line. If the tube is withdrawn from the water bath at 33°, the formation of a small cloud is observed in the region where the meniscus disappeared, and the latter is gradually reproduced in the same place. The phenomenon is not observed when the tube is inverted, or kept at 33° for 24 hours, thus allowing the two constituents to mix by diffusion. —Two experimental verifications relating to crystalline refraction by J. Verschaffelt.—Crystallographic note on the axinite of Quenast, by A. Franck.

SOCIETIES AND ACADEMIES.

London.

Physical Society, February 24.—Prof. A. W. Rücker, F.R.S., President, in the chair.—Mr. Everett, junr., read a paper on a new and handy focometer, by Prof. J. D. Everett, F.R.S., and exhibited the instrument described. The focometer is constructed on the principle of the "Lazy tongs," and so arranged that the distance between the object and screen can be varied whilst the lens is automatically kept midway between the two. This gives sharpest definition and the simplest calculation. The lazy tongs has eight cells, formed by eighteen bars $13'' \times \frac{3}{4}'' \times \frac{1}{4}''$, and is capable of being extended to about eight feet, or closed up to about one foot. Brass pins about $\frac{1}{4}''$ diameter and one and half inches long project upward from each joint in the middle row, and serve as supports for clips carrying the lens, object, and screen. The instrument can be used for any lens whose focal length lies between twenty-four inches and one inch or less. Details respecting the most appropriate objects and screens, and practical hints about the working of the instrument are given in the paper. The question of what accuracy is obtainable is also briefly discussed.—Mr. A. Hilger thought the instrument was too flexible to be used for accurate work.—Mr. Blakesley suggested that by using a plane mirror close behind the lens the light would be reflected back, and the length of the focometer could be reduced by one-half.—The President thought Prof. Everett never intended the instrument to compete, as regards accuracy, with the elaborate and expensive apparatus now used, but nevertheless the focometer was a very valuable one, especially for students' work, and was particularly well adapted to impress upon them the facts relating to conjugate foci.—A paper on a hydrodynamical proof of the equations of motion of a perforated solid, with applications to the motion of a fine framework in circulating liquids, by G. H. Bryan, M.A., was read by Dr. C. V. Burton. The object of the paper, which is a mathematical one, is to show how the equations may be deduced directly from the pressure-equation of hydrodynamics, without having recourse to the laborious method of "ignoration" of coordinates. The results are applied to determine the motion of a light framework of wires. When the framework has a single aperture it is shown that no force produces motion in its own direction, and no couple produces rotation about its own axis. In the case of a fine massless circular ring the direction of whose axis is taken as the axis of x, a constant force along the axis of y produces uniform rotation about the axis of z, and a constant couple about the axis of y produces uniform translation along the axis of z. In conclusion the author states that the results might be made to furnish mechanical explanations of certain physical phenomena. The President said the author had done good service by attacking the difficult problem by elementary methods. —Dr. C. V. Burton made a communication on plane and spherical sound-waves of finite amplitude. The first part of the paper refers to plane waves. This subject had been considered by Riemann, but Lord Rayleigh had criticised that part of Riemann's work, where it is held that a state of motion is possible in which the fluid is divided into two parts by a surface of discontinuity propagating itself with constant velocity, all the fluid on one side of the surface of discontinuity being in one uniform condition as to density and velocity, and on the other side a second uniform condition in the same respects. After quoting Lord Rayleigh's criticisms the author shows that the same objection applies when the velocity and density on either side of the surface may vary continuously in the direction of propagation, and the velocity of propagation of the surface of discontinuity is also allowed to vary. In each case the assumed motion violates the condition of energy, and can only exist under that special law of pressure for which progressive waves are of accurately permanent type. Inquiry is then made as to what becomes of waves of finite amplitude after discontinuity sets in (which condition must always occur with plane waves), in the course of which it is pointed out that the front of an air disturbance produced by a moving source which starts impulsively, travels faster than the source, even if the velocity of the source exceeds that of feeble sounds. A mechanical analogy suggests that a dissipative production of heat takes place when discontinuity occurs. In all cases Riemann had assumed that the pressure is a function of density only according to the isothermal or adiabatic law, and thus failed to take account of any heat which may be dissipatively produced. Part II. of the paper deals with spherical waves, and contains a mathematical investigation into the conditions under which the motion remains continuous or becomes discontinuous. The criterion is found in the finitude or infinitude of a certain integral. It is shown that if viscosity be neglected, then under any practically possible law of pressure the motion in spherical sound waves always becomes discontinuous. For waves diverging in four dimensions some cases occur in which the motion remains continuous. The general question of spherical sound waves of finite amplitude is then treated of, and the paper concludes with a method of finding the differential equation of an infinitesimal spherical disturbance which is superposed on a purely radial steady motion. Prof. A. S. Herschel inquired whether the nature of the solution for plane waves of finite amplitude was similar to that for ordinary waves-motion? In the latter case everything depended on the instantaneous impulses, for these alone determined the nature of the wave. The President said Mr. Boys' experiments on flying bullets might have some bearing on Dr. Burton's paper. If the conclusions there stated were correct, then the velocity of the air in front of a bullet should be greater than that of the bullet, even if the latter was travelling faster than ordinary sound waves. He now asked Mr. Boys if his photographs gave any evidence of this. Mr. Boys said the fact that the photographs showed disturbances in front of the bullet proved that the disturbance travelled faster. In one case where a large bullet was moving at a velocity rather greater than that of ordinary sound in the medium, the front of the disturbance was about half an inch in advance of the bullet. In another instance where the bullet was smaller and the velocity greater, the distance which the disturbance was in advance of the bullet was somewhat less. In all cases, even when the velocity of the bullet was four times that of sound, the character of the effects remained the same. Dr. Burton replied to the points raised.

March 10.—Prof. A. W. Rücker, F.R.S., President, in the chair.—Dr. C. V. Burton read a paper on the applicability of Lagrange's equations of motion to a general class of problems, with special reference to the motion of a perforated solid in a liquid. The paper shows that to apply Lagrange's equations it is not always necessary that the configuration of the system should be completely determined by the co ordinates, but that under certain conditions one need not consider whether the whole configuration is determined by the nature of the known co-ordinates, nor inquire what is the nature of the ignored co-ordinates. The result, which is arrived at by the aid of the "principle of least action," and the investigation given in Thomson and Tait's "Natural Philosophy," second edition, part i. § 327, is expressed by the following proposition:—If the kinetic energy of a material system can be expressed as a homogeneous quadratic function of certain generalised velocities $\dot{\psi}$, $\dot{\phi}$, . . . only, the co-efficients being functions of ψ, ϕ, . . . only, and if this remains always true so long as the only forces and impulses acting are of types corresponding to ψ, ϕ, . . ., the equations of motion for the co-ordinates ψ, ϕ, . . . may be written down from this expression for the energy in accord-

ance with the Lagrangian rule. The author then applies the proposition to the case of a perforated solid with liquid irrotationally circulating through the apertures, and shows how it may be extended to any number of perforated solids. Incidentally it is mentioned that in equations $(10)^v$ and $(10)^{vi}$ (Thomson and Tait, part i. § 327) the sign of $\partial\nu/\partial\psi$ should be reversed. A difficulty which arises in applying the result of § 319, example G, in the same work, to the motion of solids through liquids is also referred to. A criticism by Mr. A. B. Basset on Mr. Bryan's recent paper and also on Dr. Burton's paper was read by Mr. Elder. Mr. Basset regards the process employed by Mr. Bryan in obtaining the equations of motion as a distinctly retrograde step, and thinks the most scientific way of dealing with dynamical problems is to avoid the unnecessary introduction of any unknown reactions. The advantages of the theory of the impulse are described by Mr. Basset, and the parts which require care when applying the theory to cyclic irrotational motion pointed out. Comparisons are then made as regards simplicity, between the different methods of treating the subject which have been used by Mr. Bryan, Prof. Lamb, and himself. With reference to Dr. Burton's paper he thinks it will tend to complicate rather than elucidate the subject. An account of how Lagrange's original equations had been modified by Hamilton, Routh, and himself is given at some length, and the advantages and power of the mixed transformation, which he had developed are pointed out. Prof. Henrici said he agreed with Mr. Basset in preferring the more general method, but thought the independent treatment of special problems as given by Mr. Bryan and Dr. Burton, very desirable.—Dr. Burton in reply said he concurred with Mr. Basset on some points, but thought it decidedly advantageous to look at problems from different points of view. The investigation he (Dr. Burton) had given was applicable to any number of solids, and on the whole simpler than Mr. Basset's. The President pointed out that no attack had been made on the validity or accuracy of Mr. Bryan's or Dr. Burton's work. As to simplicity of the various methods, different opinions might be expected to exist. He himself thought it very desirable that such problems should be approached from different sides.—Prof. G. M. Minchin read a paper on the magnetic field of a circular current.—A paper on the differental equation of electric flow, by Mr. T. H. Blakesley, was postponed.

Royal Microscopical Society, February 15.—Mr. A. D. Michael, President, in the chair.—Mr. E. M. Nelson exhibited a microscope made by Messrs. Watson, to which several novelties had been applied.—Mr. J. W. Lovibond read a note on the measurement of direct light by means of the tintometer. Mr. Nelson said that the wonderful results obtained by the author by means of his instrument were perfectly surprising. It was, in fact, equal to discovering differences down to millionths of a tint; having had the pleasure of seeing and using it he soon found that there was a very decided difference in the colour sensation of his own eyes, which until that time he had never suspected. It had done such marvels when applied to macroscopic purposes that he did not doubt it would do much also when applied to microscopic studies. — Mr. G. S. Marriott's form of mounting and dissecting stand was exhibited and described by Mr. Nelson.—Mr. T. F. Smith read a paper on the use of monochromatic yellow light in photomicrography.—Prof. F. J. Bell read a letter from Dr. H. G. Piffard bearing on the same subject.—A paper descriptive of two species of rotifers by Mr. J. Hood was also read by Prof. Bell.—Mr. Nelson read a paper on the chromatic curves of microscope objectives.—Dr. W. H. Dallinger said that Mr. Nelson was quite right in pointing out that unless we could devise means for employing the shorter wave-lengths of the spectrum we had approached very near to the limits of visual possibility with the means at present at our disposal. But as to the belief expressed by Mr. Nelson that glass such as was used in our objectives was not transparent to the higher violet and ultra-violet rays, and to some extent also to the blue, it must be remarked that there could be no doubt but that the figures of the lenses had much to do with this; it led them up to the consideration of the question as to what would be a suitable form and medium for lenses capable of allowing the higher rays to be used. There could be little doubt that all who believed in a future advantage in the use of monochromatic light foresaw that there must be lenses specially prepared for its use. They all knew now that they had reached the limit of possibility so far as present materials were concerned; for if a lens could be made with a N.A. of 2·00, there was no liquid medium to use with it, because no medium so employed would be tolerant of living or even organic substances. If, therefore, they could by some means use shortened wave-lengths, they would have accomplished something extremely useful.—The rest of the agenda was postponed in consequence of the lateness of the hour.

Entomological Society, March 8.—Capt. Elwes, President, in the chair.—Herr Pastor Wallengren, of Farhult, bei Höganäs Sweden, and Herr Hofrath Dr. Carl Brunner Von-Wattenwyl, of Vienna, were elected Honorary Fellows of the Society to fill the vacancies in the list of Honorary Fellows caused by the deaths of Prof. Hermann C. C. Burmeister and Dr. Carl August Dohrn.—Dr. D. Sharp, F.R.S., exhibited a fine species of *Enoplotrupes* from Siam, which was believed to be new, and which he thought Mr. Lewis intended to describe under the name of *E. principalis*. This insect has great power of making a noise, and the female seemed in this respect to surpass the male.—Mr. W. F. H. Blandford said he wished to supplement the remarks which he made at the meeting of the Society on February 8 last, on the larva of *Rhynchophorus*. He stated that he had since found that only the first seven pairs of abdominal stigmata were rudimentary. The posterior pair were well developed and displaced on to the dorsum of their segment, which was thickly chitinised, and bore a deep depression, on the margins of which the spiracles were situated. He added that dissection showed that the posterior pair were the principal agents of respiration.—Mr. W. H. B. Fletcher exhibited a long series of bred *Zygæna lonicera* and *Z. trifolii*, hybrids of the first generation with the following parentage:—*Z. lonicera*, male—*Z. trifolii*, female; *Z. trifolii*, male—*Z. lonicera*, female; also hybrids of the second generation between *Z. trifolii*—hybrid, and *Z. lonicera*—hybrid. He stated that many of the hybrids were larger than the parent species, and that some hybrids between *Z. lonicera* and *Z. filipendulæ* were the largest he had ever seen. He added that *Zygæna meliloti* would not hybridise with *Z. lonicera*, *Z. trifolii* or *Z. filipendulæ*.—Mr. F. W. Frohawk exhibited a bred series of *Vanessa atalanta*, showing the amount of variation in the red band on the fore wings of the female.—Capt. Elwes exhibited a large number of specimens of *Chrysophanus phlæas* from various places in Europe, Asia, and North America, with the object of showing that the species is scarcely affected by variations of temperature, which was contrary to the opinion expressed by Mr. Merrifield in his recent paper on the effects of temperature on colouring. Mr. McLachlan, F.R.S., Mr. A. J. Chitty, Mr. Bethune-Baker, Mr. Tutt, and Mr. Barrett, took part in the discussion which ensued.—Dr. Sharp read a paper entitled "On Stridulating Ants." He said that examination revealed the existence in ants of the most perfect stridulating or sound-producing organs yet discovered in insects, which are situated on the 2nd and 3rd segments of the abdomen of certain species. He was of opinion that the structures which Sir John Lubbock thought might be stridulating organs in *Lasius flavus* were not really such, but merely a portion of the general sculpture of the surface. Dr. Sharp said that the sounds produced were of the greatest delicacy, and Mr. Goss had been in communication with Mr. W. H. Preece, F.R.S., with the view of ascertaining whether the microphone would assist the human ear in the detection of sounds produced by ants. Mr. Preece had stated that the microphone did not magnify, but merely reproduced sound, and that the only sounds made by ants which he had been able to detect by means of the instrument were due to the mechanical disturbance produced by the motion of the insects over the microphone. A long discussion ensued, in which the President, Canon Fowler, and Messrs. Champion, McLachlan, Goss, Hampson, Barrett, Burns, and Jacoby, took part.—Mr. C. J. Gahan read a paper entitled "Notes on the Longicornia of Australia and Tasmania, Part I.; including a list of the species collected by Mr. J. J. Walker, R.N."

Geological Society, March 8.—W. H. Hudleston, F.R.S., President, in the chair.—The following communications were read:—On the occurrence of boulders and pebbles from the glacial drift in gravels south of the Thames, by Horace W. Monckton. North of the Thames near London, the glacial drift consists largely of gravel, which is characterised by an abundance of pebbles of red quartzite and boulders of quartz and igneous

rock. With the exception of very rare boulders of quartz, the hill and valley-gravels of the greater part of Kent, Surrey, and Berkshire are entirely free from these materials. The author points out that the river Thames is not, however, the actual southern boundary of the distribution of these glacial drift pebbles and boulders, though the number of localities where they are found in gravels south of that river is few. The author describes or mentions several, of which the following are the most important:—Tilehurst, Reading, Sonning, Bisham at 351 feet above the sea, Maidenhead, Kingston, Wimbledon, and Dartford Heath.—On the plateau-gravel south of Reading, by O. A. Shrubsole. This paper contains observations on the gravel of the Easthampstead-Yately plateau. The constituent elements of the gravel are described, and the author notes pebbles of non-local material near Cæsar's Camp, Easthampstead, on the Finchampstead Ridges, and at Gallows Tree Pit at the summit of the Chobham Ridges plateau. He mentions instances of stones from the gravel of the plateau (described in the paper) which may bear marks of human workmanship. He furthermore argues that the inclusion of pebbles of non-local origin in the gravels may be due to submergence of the plateau up to a height of at least 400 feet above present sea-level, and cites other facts in support of this suggestion. He concludes that the precise age of the gravel can only be more or less of a guess, until the mode of its formation has been definitely ascertained. The reading of these papers was followed by a discussion, in which the President, Dr. Hicks, Mr. J. A. Brown, Prof. J. F. Blake, Mr. W. J. L. Abbott, Mr. Herries, Mr. Monckton, and Mr. Shrubsole took part.—A fossiliferous pleistocene deposit at Stone, on the Hampshire Coast, by Clement Reid. (Communicated by permission of the Director-General of the Geological Survey.) This is practically a supplement to a paper on the pleistocene deposits of the Sussex coast, that appeared in the last volume of the *Quarterly Journal*. An equivalent of the mud-deposit of Selsey has now been discovered about twenty miles farther west, and from it have been obtained elephant-remains, and some mollusca and plants like those found at Selsey. Among the plants is a South European maple. Some remarks were made on the paper by the President, Dr. Hicks, and Mr. W. J. L. Abbott, and the author replied.

Zoological Society, March 14.—Sir W. H. Fowler, F.R.S., President, in the chair.—The Secretary read a report on the additions that had been made to the Society's menagerie during the month of February, 1893, and called attention to two terrapins procured on Okinawa Shima or Great Loochoo Island by Mr. P. A. Holst, and kindly presented by that gentleman. Mr. Boulenger had determined these tortoises as being Spengler's terrapin (*Nicoria spengleri*).—Mr. O. Thomas exhibited and made remarks on a rare antelope (*Nanotragus livingstonianus*) from Northern Zululand.—Dr. Forsyth-Major exhibited and made remarks on a tooth of *Orycteropus* from the Upper Miocene of Maragha, Persia, which he referred to *O. gaudryi*, of the Upper Miocene of Samos. Drawings of the remains of the latter were exhibited, as well as a photograph of a femur of a struthious bird from the same deposit in Samos. The habitats of *Struthio* and *Orycteropus* were thus shown to have been essentially identical in past times, as in the present. Therefore the general conclusions to be drawn from their geographical distribution would apply equally to both.—Mr. Oldfield Thomas made some suggestions for the more definite use of the word "type" and its compounds, as denoting specimens of a greater or less degree of authenticity.—Mr. P. L. Sclater, F.R.S., pointed out the characters of a new African monkey of the genus *Cercopithecus;* and took the opportunity of giving a list of the species of this genus known to him, altogether 31 in number, together with remarks on their exact localities.—Prof. F. Jeffrey Bell read a paper on *Odontaster* and the allied and synonymous genera of the Asteroidea.—Mr. A. D. Michael read a paper upon a new species (and genus) of *Acarus* found in Cornwall. The creature in question, which it was proposed to call *Lentungula algivorans*, was found in some quantity on a green alga (*Cladophora fracta*) near the Land's End. It was a minute creature belonging to the family Tyroglyphidæ, the remarkable feature about it being that, whereas the two hind pairs of legs were terminated by a hard and powerful single claw (which claw sprang from the end of the tarsus), the two front pairs had the tarsus itself hardened and curved strongly downward, forming clinging- and walking-organs; while from the side of the tarsus sprang a long peduncle, flexible in all directions at the will of the creature, and bearing an exceedingly minute claw. This apparatus was not used in climbing, but had become wholly tactile. Such an arrangement was previously unknown in the Acarina.—Prof. Howes described some abnormal vertebræ of certain Ranidæ (*Rana catesbiana*, *R. esculenta*, and *R. macrodon*) in which the so-called "atlas" possessed transverse processes and trans-atlantal nerves. Prof. Howes discussed the bearings of these specimens on the morphology of the parts, deducing the argument that the first vertebra of the Amphibia is probably to be regarded as a representative of at least two vertebræ, of which the formative blastema has become merged in the occiput in the Amniota. The author also described a stage in the development of the urostyle of *Pelobates*, and showed that, in this Batrachian, there is a provisional inversion in the order of development of the parts of the urostyle and precoccygeal vertebræ. He also described a reduced hind limb of *Salamandra maculosa*, in which the reduction and fusion of the parts remaining realised the condition normal for the Urodele limb with numerically reduced digits.

Royal Meteorological Society, March 15.—Dr. C. Theodore Williams, President, in the chair.—Mr. Shelford Bidwell, F.R.S., delivered a lecture on some meteorological problems, which was illustrated with numerous photographs and experiments. The lecturer said that one of the oldest and still unsolved problems of meteorology relates to the origin of atmospheric electricity. Many possible sources have been suggested, among them being the evaporation of water and the friction of dust-laden air against the earth's surface. Having granted some sufficient source of electrification, Mr. Bidwell said that it is not difficult to account for the ordinary phenomena of thunderstorms. Photography has shown that the lightning flash of the artists, formed of a number of perfectly straight lines arranged in a zig-zag, has no resemblance to anything in nature. The normal or typical flash is like the ordinary spark discharge of an electrical machine, it follows a sinuous course, strikingly similar to that of a river as shown upon a map. The several variations from the normal type all have their counterparts in the forms taken by the machine spark under different conditions, and the known properties of these artificial discharges may be assumed to afford some indication as to the nature of the corresponding natural flashes. Thus, for example, the ramified or branched flash, from which no doubt the dreaded "fork lightning" derives its name, is probably one of the most harmless forms of discharge. Ever since the time of Franklin it has been customary to employ lightning rods for the protection of important buildings. According to Dr. Oliver Lodge these are of no use in the case of an "impulsive rush" discharge, which, however, is of comparatively rare occurrence. Lightning conductors, however well constructed, cannot therefore be depended upon to afford perfect immunity from risk. Mr. Preece is of opinion that the "impulsive rush," though easily producible in the laboratory, never occurs in nature. Mr. Bidwell made some remarks as to the duration of a lightning flash and the causes of its proverbial quiver, and suggested an explanation of the characteristic darkness of thunder clouds, and of the large rain-drops which fall during a thunder shower. The lecturer concluded with some observations concerning the probable cause of sunset colours, which he attributed to the presence of minute particles of dust in the air.

OXFORD.

University Junior Scientific Club, March 1.—The President in the chair.—Mr. C. H. H. Walker exhibited some compounds of the rare metals from the collection of the late Duke of Marlborough, which had been presented to the University by the Duchess.—Among the papers read was one by Dr. Leonard Hill on cortical localisation.

March 10.—The President in the chair.—Adjourned discussion on Dr. L. E. Hill's paper on cortical localisation.

CAMBRIDGE.

Philosophical Society, February 27.—Prof. T. McK. Hughes, President, in the chair.—The following communications were made to the Society:—On the histology of the blood of rabbits which have been rendered immune to anthrax, by Lim Boon Keng. The research was conducted in the pathological laboratory of the University. The rabbits were rendered

immune to anthrax by inoculation with the lymph and blood of frogs which had been subjected to various treatment. Previous observers had succeeded in conferring immunity with the use of similar substances. The object of the investigation, however, was to ascertain the changes in the character and relative number of the white cells of the blood after protective vaccination and after the introduction of virulent anthrax. From four to several hours after the injection of the vaccine a great increase in the number of the white cells is noticeable; and the most remarkable feature is the augmentation in number of the coarsely granular (eosinophile) corpuscles. The relative proportion in the numbers of the different varieties of cells is therefore altered, so that instead of forming only from 2 to 4 per cent. of the total number of white cells, the eosinophile corpuscles now constitute about 10 to 25 per cent. This increase persists only a short time, and on the third day the cells may have returned to a normal condition; and at this stage hyaline cells ingesting granular cells may be detected in numbers in certain localities. Although the blood has thus apparently returned to the normal condition, it is found that the state of eosinophile leucocytosis is rapidly reproduced on the introduction of virulent anthrax. After inoculation with a virulent culture of the microbes, the eosinophile cells appear in great numbers, so that they may form 50 per cent. of the white corpuscles, and in one instance an even higher percentage was found. These cells are not only increased in number but are also larger and have larger granules. Similar changes were observed in guinea pigs rendered immune by Dr. Haffkine to the common bacillus. In non-vaccinated rabbits the introduction of anthrax causes profound leucocytosis, but the cells are all very small and the eosinophile corpuscles are only slightly increased in number. General infection occurs in 36 to 48 hours, rapidly followed by death.—On numerical variation in digits, in illustration of a principle of symmetry, by Mr. W. Bateson. An account was given of cases of variation in number of digits so occurring that the parts are symmetrical about a new axis in the limb. Of these the phenomena seen in the bones of a number of polydactyle cats were chiefly important. The normal hind foot of the cat has four toes, each bearing a claw retracted by an elastic ligament to a notch on the *external* side of the second phalanx. This circumstance differentiates digits formed as lefts from those formed as rights. As extra digits are added on the internal side of the limb the symmetry changes. The limb being taken as a *right*, the variations seen are as follows: (1) Hallux present, making five digits: index is then *intermediate between right and left*. (2) Six digits present, internal having two phalanges: the three external digits are then normal rights, *the next two are formed as lefts*; the internal, having a non-retractile claw, is indifferent. (3) Six digits present, internal having three fully-formed phalanges and rectractile claw: the three externals are then normal rtghts, and *the three internals are formed as left digits*, thus forming two groups in bilateral symmetry about an axis passing between the digits having the relations of index and medius. Several cases of "double hand" in Man form a similar progressive series, and analogous facts in other animals were instanced.

PARIS.

Academy of Sciences, March 13.—M. Lœwy in the chair.—On the true theory of waterspouts and tornadoes, with special reference to that of Lawrence, Massachusetts, by M. H. Faye. The tornado which ravaged the town of Lawrence on July 26, 1891, was observed to descend to the earth and reascend four times during its passage over a tract of country seventeen miles long. After each temporary ascent to the clouds no effect was produced on the land just below. This fact tends to confirm M. Faye's theory, according to which tornadoes, waterspouts, and cyclones have their origin not in hot convection currents from the soil, but in disturbances in the higher strata of the atmosphere. The observed cases of upward suction of heavy objects are explained as effects of the reflection of downward currents by the soil.—On an electric furnace, by MM. Henri Moissan and Jules Violle (see "Notes").—The pancreas and the nervous centres controlling the glycemic function; experiments tending to exhibit the parts played by each of these agents respectively in the formation of glycose by the liver, by MM. A. Chauveau and M. Kaufmann.—Description of a new species of bilateral Holothuria (*Georisia ornata*), by M. Edmond Perrier.—On the observation of the shadows of Jupiter's satellites, by M. J. J. Landerer.—On the formulæ for annual aberration, by M. Gaillot.—On the transcendentals defined by the differential equations of the second order, by M. Paul Painlevé.—A theorem of infinitesimal geometry, by M. G. Kœnigs.—New semicircular interference fringes, by M. G. Meslin.—Photography of certain phenomena furnished by combinations of gratings, by M. Izarn. On placing a lens with large radius of curvature upon a grating, broad rings, concentric with the Newton's rings observed at the same time, were seen and fixed photographically by means of a layer of sensitised gelatine poured over the lens. On placing one photographic copy of a grating upon another of the same grating, a series of more or less rectilinear fringes was observed, running on the whole transversely to the rulings. A similar phenomenon is described by Brewster in the *Philosophical Magazine* of 1856.—Photographic properties of cerium salts, by MM. Auguste and Louis Lumière. Cerium gives rise to two principal types of salts, cerous and ceric. The former are very stable, the latter are easily reduced, the organic salts being so easily reduced that they cannot be isolated. The best photographic results were obtained with ceric sulphate and nitrate. Paper was soaked in aqueous solutions of these salts and exposed to light under a transparency obtained from a negative. Where the light penetrated, the ceric salt was reduced and the paper changed colour. The image was developed by treating with some carbon compound of the aromatic series, forming an insoluble pigment with the unreduced ceric salt, and fixed by washing. In an acid solution the prints turned grey with phenol, green with aniline salts and orthotoluidine, brown with amidobenzoic acid, &c. The ceric salts are considerably more sensitive than the corresponding ferric and manganic salts.—Intense and rapid heating process by means of the electric current, by MM. Lagrange and Hoho. A bar of steel 1 cm. thick formed one electrode of a strong current passing through an electrolyte. The other electrode had a large surface. The heating was so rapid that, on breaking the current, the liquid suddenly cooling the bar was found to have imparted a brittle structure only to a superficial layer, the rest not having been heated (see also the *Bulletin* of the Belgian Academy).—On metallic osmium, by MM. A. Joly and M. Vèzes (see "Notes").—Researches on thallium; redetermination of its atomic weight, by M. Ch. Lepierre.—On the fluorides of zinc and cadmium, by M. Poulenc.—Quantitative determination of mercury in dilute solutions of sublimate, by M. Léo Vignon.—Alkaline polyphenolic phenates, by M. de Forcrand.—Isomerism of the amido-benzoic acids, by M. Oechsner de Coninck.—Action of carbonic oxide upon reduced hæmatine and upon hæmochromogen, by MM. H. Bertin-Sans and J. Moitessier.—The toxic substance which produces tetanus results from the action of a soluble ferment produced by Nicolaïer's bacillus, by MM. J. Courmont and H. Doyon.—Action of cold on visceral circulation, by M. E. Wertheimer.—On the affinities of the genus *Oreosoma*, Cuvier, by M. Léon Vaillant.—On a new mineral species from Bamle, Norway, by M. Leopold Michel.—On a chloritoid schist of the Carpathians, by MM. L. Duparc and L. Mrazec.

BERLIN.

Physical Society, February 10.—Prof. du Bois Reymond, President, in the chair.—Dr. Raps exhibited and explained a photographic registration-apparatus which he had constructed, primarily for the purpose of obtaining a permanent record of the readings of the voltmeter at central electric stations, but which could also be used for meteorological and physical purposes. The principle of the instrument is as follows. Parallel rays from an incandescent lamp are made to fall on a narrow slit in front of which is the recording needle of the voltmeter or other instrument. The shadow of this needle then causes a white break in the dark image of the slit as cast on to sensitised paper. The paper is moved forward by clockwork, and the hour-intervals are simultaneously printed on it by means of a rotating glass disc. The apparatus is arranged so as not to necessitate any dark chamber for its use, or for the manipulation of the sensitised paper. Prof. Kundt exhibited as lantern pictures two photographs of spectra, of which one showed very marked colours from the red to the violet end, and a photograph of some green twigs with red berries on them. The three photographs had been taken by Lippmann in Paris, and sent to Prof. von Helmholtz. Prof. Kundt then gave an account of some experiments carried on in his laboratory on the influence of temperature on electromagnetic rotation of light in iron, cobalt, and nickel. Trustworthy results

could only be obtained with nickel owing to the oxidation of the thin films of iron and cobalt at high temperatures (300°). With nickel a rise of temperature produced at first no change in the rotation, but above 300° a sudden diminution was observed which rapidly became progressively greater; the relationship of the diminution of rotation to the increase of temperature was the same as for the magnetic susceptibility of the metal.

February 24.—Prof. Schwalbe, President, in the chair.—Dr. Raps demonstrated his latest and most improved form of automatic gas-pump for blood-gas analysis. Dr. Richarz developed, in accordance with the kinetic theory of gases, and under certain assumptions as to the constitution of solid bodies, the formulæ for the law of Dulong and Petit. The formulæ furnished an explanation of the divergence from this law which is exhibited by certain elements. Dr. Gross spoke on the laws of energy, proceeding with his criticism of Clausius's views, stating that he regarded Clausius's second law as unproved, and finally coming to the conclusion that entropy is constant.

Physiological Society, February 17.—Prof. Zuntz, President, in the chair.—Dr. von Noorden gave an account of four experiments on nutrition carried out under his direction on men. The first established the fact that nitrogenous waste, as in the case of diabetes, even when excess of proteid is given, can be most definitely lessened by the ingestion of large quantities of carbohydrates. Fats cannot take the place of carbohydrates in the above. The second showed that when carbohydrates are given in increasing quantities over a prolonged period to a person in nitrogenous and calorimetric equilibrium, they lead for the most part to a storage of fat (95 per cent.), and to a less extent of proteid (5 per cent.). The speaker expressed the opinion that this proteid is laid on in the living cell as a sort of non-living reserve proteid. The third set of experiments showed that when the food of a fat person is diminished down to the requirements of a seven- to ten-year-old child, then any increase of its proteid constituents leads to a storage of proteid with a simultaneously considerable loss of fat. Experiments on the respiratory interchange of the person experimented upon showed that the intake of oxygen had been reduced to a minimum and that the respiratory quotient was 0·7. The last set of experiments, made on a gouty patient, showed that with a constant diet, the ratio of intake and output of nitrogen was very variable, at one time a large amount of nitrogen being retained in the body while at another time much more nitrogen was excreted than was given with the food.

AMSTERDAM.

Royal Academy of Sciences, February 25.—Prof. van de Sande Bakhuyzen in the chair.—Mr. Weber read a paper on the origin of the mammalian hair. The author gave a *résumé* of his earlier researches on the scales of mammals, which led him to the hypothesis that the primitive mammals were covered with true scales. A weak point in this hypothesis was, that except Manis and the Dasypodidæ, generally the tail alone is scaled. The author showed, however, that according to the researches of H. de Meyere, the arrangement of the hairs on scaleless skin of numerous mammals is the same as that in scaled parts. Both are placed in alternating groups. The author believed that primitive mammals were covered with scales, and that few and small hairs were placed behind them. On acquiring a constant temperature the hair coat got denser as a good protection from loss of heat. This was the cause of the reduction of the scales, and also mostly of their final loss.—Mr. Lorentz dealt with the influence of the motion of the earth on the propagation of light in doubly refracting media. In the September meeting the author communicated a simple form for the equations which determine the propagation of light in isotropic bodies, moving through the æther with a constant velocity p, the æther itself being supposed to remain at rest. It is now shown how these formulæ are to be modified in the case of a crystallised medium, and to what consequences they lead, as to the motion of light, relatively to the ponderable matter. The velocity of propagation of a *ray of light* (to be distinguished from that of the waves) is found to be $W = W_0 - \frac{p}{n^2} \cos \delta$; W_0 being the value for the same direction and for $p = o$, δ the angle between the ray and the velocity p, V the velocity of light *in vacuo*, and $n = \frac{V}{W_0}$. The course of reflected and refracted rays may be deduced from Huygens's principle or from the condition that $\int \frac{ds}{W}$ must be a minimum (ds being a linear element). Owing to the above value of W, the motion of the earth will neither affect the course of the rays nor the interference phenomena. In this way some experimental results of Ketteler (*Astronomische Undulationstheorie*, pp. 151–173, *Pogg. Ann* Bd. 147), and Mascart (*Ann. de l'Ecole normale*, 2e série, t. i. pp. 191–196) may be explained.—Mr. Kamerlingh Onnes gave the results of measurements of Dr. Zeeman on the dispersion of Sissingh's magneto-optic difference of phase in Kerr's phenomenon. The dispersion is contrary to the theory of Drude.—He described further a new entoptical phenomenon found by Dr. Zeeman in sighting a split, and communicated the results of the measurements of Dr. de Vries on the variation of the ascension of capillary tubes for æther with the temperature from − 102°C. to the critical temperature 193°·6. The surface work plotted in function of temperature gives a curve turning the convex side to the axis of temperature and ending tangentially to it.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—An Elementary Treatise on Pure Geometry: J. W. Russell (Clarendon Press).—Comité International des Poids et Mesures, Quinzième Rapport (Paris, Gauthier-Villars).—The Intelligence of Animals: G. W. Purnell (Christchurch, N.Z., Whitcombe and Tombs).—How to Improve the Physique: "Medicus" (Stock).—Handbook of Jamaica, 1893 (Stanford).—Modern Meteorology: Dr. F. Waldo (Scott).—Gesammelte Abhandlungen über Pflanzen Physiologie: J. Sachs, Zweiter Band (Leipzig, Engelmann).—An Elementary Treatise on Modern Pure Geometry: R. Lachlan (Macmillan).—The Food of Plants: A. P. Laurie (Macmillan).—Elements of Physiography: Dr. H. Dickie (Collins).

PAMPHLETS.—Ueber die Bestimmung der Geographischen Länge und Breite und der Drei Elemente des Erdmagnetismus, &c.: Dr. H. Fritsche (St Petersburg).—Diseases incident to Workpeople in Chemical and other Industries: W. Smith (Eyre and Spottiswoode).

SERIALS.—Himmel und Erde. Marz (Berlin, Paetel).—Revista Internazionale di Scienze Sociali e Discipline Ausiliarie, February (Roma).—Journal of the Chemical Society, March (Gurney and Jackson).—Annales de l'Observatoire de Moscou, deux série, vol 3, liv. 1 (Moscou).—Medical Magazine, March (Southwood).—Botanische Jahrbucher, Fünfzehnter Band, v. Heft (Williams and Norgate).—Transactions of the Wagner Free Institute of Science of Philadelphia, vol. 3, part 2 (Philadelphia).

CONTENTS.

THURSDAY, MARCH 30, 1893.

ELECTROMAGNETIC WAVES.

Electrical Papers. Two vols. By Oliver Heaviside. (London: Macmillan and Co., 1892.)

IN these two volumes the author has collected the papers on electrical subjects which he has rom time to time contributed to the *Philosophical Magazine*, the *Philosophical Transactions*, the *Electrician*, and other technical journals. The result is a work of some eleven hundred closely printed octavo pages; that is to say, on a rough estimate, it contains in printed matter about half as much again as Maxwell's two volumes on Electricity and Magnetism, and considerably more than the two volumes of Thomson and Tait. When we add that the author brings into action freely (though with perfect mastery) some of the most elaborate weapons of mathematical physics, and that considerable passages are moreover written in a special condensed notation, it will be evident that the task of the reviewer is no easy one. All that we shall here attempt is to give a general idea of the nature of the book, with some reference to its more original features.

The first few articles are devoted to practical questions, such as duplex telegraphy, signalling with condensers, the best arrangement of Wheatstone's bridge, and so on. These are thoroughly readable, and, apart from their technical value, may be commended to mathematical students as containing interesting concrete applications of electrical theory. The rest of the book is partly a commentary on, and partly a development of, the latter part of Maxwell's treatise, and deals mainly with the propagation of electromagnetic effects in space and time. It is therefore closely connected with the theoretical work of Poynting and J. J. Thomson on the one hand, and with the practical investigations of Hertz and his followers on the other. At the present time there is no great difficulty in following in imagination the propagation of inductive effects from one conductor to another across the intervening space; and that this should be the case is due in no small degree to the labours of our author, for although probably few readers have been found to follow him step by step, yet many have admired the tenacity with which he attacks problem after problem bearing on his subject, and have gathered valuable ideas and suggestions from his exuberant pages.

One of the most noteworthy features in the author's theoretical work is the elimination of the "vector-potential" from Maxwell's equations of the electromagnetic field, with the result that the equations in question are obtained in a "duplex form" in which there is perfect symmetry as regards the parts played by the electric and the magnetic variables respectively, so that the equations are unaltered in form when a reciprocal substitution between the two sets of variables is made. The same simplification has been made independently by Hertz. It is of importance for this reason, that the vector-potential is to a certain extent indeterminate. This was indeed insisted upon by Maxwell himself, but, strange to say, he did not always remember his own warning, with the result that more than one most important passage of his great work is rendered needlessly obscure. Another function which the author seeks (we think rightly) to relegate to the position of a mere mathematical implement, without physical significance beyond the domain of electrostatics, is the electric potential. There is nothing paradoxical in this, for the original definition of this function postulates a state of equilibrium.

The last paper (but one) in the book forms a sort of crown to the whole. It is entitled "On the Forces, Stresses, and Fluxes of Energy in the Electromagnetic Field," and is reprinted from the *Philosophical Transactions* for 1892 (A). Unfortunately this paper is by far the hardest to read. Free use is made of the scalar and vector products of Hamilton, but the author is careful to give us his emphatic opinion that quaternions proper are unsuited to the purposes of mathematical physics. This courageous declaration will, we fear, cause a wicked joy in the hearts of many who have struggled in vain with these refractory symbols. For the special system of mathematical shorthand affected by Mr. Heaviside there is much to be said, but for our own part we should prefer to have papers which profess to give new and important results written in the more homely language of "Mr. Cartesian." Another prominent feature in this memoir is the frequent appeal to the principle of "continuity of energy," but this imposing phrase seems to mean nothing more nor less than Maxwell's negation of action at a distance. The author, indeed, takes care to explain that he does not countenance the notion of "identity of energy" which one prominent physicist has attempted to base on a well-known paper by Poynting. It is now generally recognised that the flux of energy in the electromagnetic field is indeterminate. In his treatment of induction in moving media, a very important but most difficult subject, the author is led to at least one definite conclusion of great interest, viz. the existence of a magnetic force acting on a body moved across the lines of electric induction, just as there is an electric force on a body moved across the lines of magnetic induction. This is in conformity with the duplex character of the fundamental equations already referred to. Finally, we must not omit to notice a somewhat startling proposal for a radical change in the system of electric and magnetic units. In the "rational" system advocated by our author, *one* line of force would emanate from a unit magnetic pole, instead of 4π such lines, so that the force between two poles m,m' at a distance r apart would be $mm'/4\pi r^2$ instead of mm'/r^2 as at present. The existing system is denounced as containing an absurdity of the same nature as if we were to define the unit area to be the area of a circle of unit diameter.

It remains to say a word or two about the style in which the book is written. It is exceedingly fluent, often discursive, and occasionally boisterous, as when the author, introducing the functions called zonal harmonics, remarks that "these are Murphy's P's; *not praties*, but the functions invented by Murphy"; or again, when in his impatience of vector and other potential functions he gives utterance to the wish to "*murder the whole lot.*" A more serious matter is that the papers in these volumes often overlap, whilst the frequent cross-

 A A

references make it difficult to detach any one from the rest, or to gather the substance of the author's speculations on any one part of his subject. In the preface he tells us that he had been urged to publish not a reprint, but a systematic treatise. It is, we think, greatly to be regretted that he has not found it possible to take this advice. The labour of compression and of proper co-ordination would no doubt have been great, but it would have been amply repaid by the increased currency given to the author's views. As it is, we fear that the fate of these weighty volumes will be that students of the stamp which Mr. Heaviside would most wish to attract will turn over his pages, picking up a suggestion here and there, will then work out things in their own way, and finally return to the present treatise to ascertain how far their results have been anticipated. And this is really matter for regret, for almost every page bears the impress of a vigorous and original mind, and we cannot doubt that the author's speculations would have exercised a considerable influence on the progress of electromagnetic theory, if it had not been for the disadvantageous form under which they are presented. H. L.

THE GREAT SEA-SERPENT.

The Great Sea-Serpent. An Historical and Critical Treatise. With Reports of 187 Appearances (including those of the Appendix), the Suppositions and Suggestions of Scientific and Non-scientific Persons, and the Author's Conclusions. With 82 illustrations. By A. C. Oudemans, Jzn. Published by the Author, October, 1892. (London : Luzac and Co.)

IN a large, well-printed volume, Dr. A. C. Oudemans, Jzn., publishes what he is pleased to call "an historical and critical treatise" about the "Great Sea-Serpent," with the reports of 187 appearances, the suppositions and suggestions of scientific and non-scientific persons, and the author's conclusions.

It is impossible, however, to treat this laborious work as a scientific treatise, nor will the author, we trust, be vexed with us when we add that it is the very last form of a work that we would have expected from the pen of the learned Director of the Zoological Gardens at the Hague. for when one gets by practise to know the utter worthlessness of the descriptions given by even well-educated persons of often the most easily diagnosed forms of life—and surely experience of this nature must often have come across Dr. Oudemans's path—one cannot fail to regard as positively hopeless the reconciling of a mass of such crude observations as fill the pages of this book. The very trouble and no doubt anxiety caused by reading over such a pitiful series of records has to some extent affected the author, for he quotes as the motto for his volume the extremely sensible words of a very able biologist, whose chief fault it was not to leave a greater record of his wisdom for posterity, to the effect "That it is always unsafe to deny positively any phenomena that may be wholly or in part inexplicable," meaning thereby to deny a phenomenon because it cannot be explained, and then in the immediately following preface he compares himself to Chladni, who took the trouble to collect all the accounts concerning observations of "meteoric stones," and showed the immense number of *facts* that he had found out about them. In this one word fact—*fact*—lies a great world of difference between Chladni's meteoric stones and Oudemans's sea-serpents. The meteoric stones could be seen and handled, the sea-serpents "are very shy, and it is not advisable to approach them with a steamboat." "Instantaneous photographs of the animal will alone convince zoologists, while all their reports and pencil drawings will be received with a shrug of the shoulders"; this latter sentence, which precedes the preface, makes one shudder at the amount of "reports and pencil drawings" contained in the six hundred following pages.

And yet, perhaps, this work is not altogether without its value. From the middle of the sixteenth century—when Olaus Magnus wrote about "a very large serpent of a length of upwards of 200 feet and twenty feet in diameter, which lived in rocks and holes near the shore of Bergin" —until this very present hour all sorts and manners of gigantic forms have been reported about by sailors and others, and even pencil drawings of them have been made, and the collecting together and printing of such a series of records forms as strange a chapter of the science known by the people as has ever made its appearance.

There is but little necessity of insisting on the need of experience in seeing ere one can describe what is seen, nor on the need of a power of describing what one correctly sees so that the description may be applicable, nor need one wonder that such powers of seeing and describing were not to be found united in the many seagoing worthies whose extraordinary narratives crowd the pages of this volume. But what are we to say about the capacity for belief to be found in the compiler of this work, who concludes his task by naming a form he has never seen, *Megophias megophias* (Raf.) Oud., and further thinks that a Phylogenetic table, which he gives, "will in a practical manner show the rank which, in my opinion, sea-serpents occupy in the system of nature"?

This volume contains an account of the "literature" on the subject of sea-serpents; a detailed record of the various accounts and reports concerning observations of sea-serpents chronologically arranged and thoroughly discussed; and criticisms on the papers written on the same subject; next the various explanations hitherto given, and lastly the author's own conclusions—these he divides into "fables, fictions, exaggerations and errors," and what he is pleased to call "facts." Among the fictions he regards the belief that the sea-serpent "casts its skin, as common snakes do, and that it is born on land"; among the exaggerations that it has "a tail fully a hundred and fifty feet in length"! among the errors "that there are *two* species of sea-serpents, or that there are several species of them all belonging to the same genus"; or that "it ever takes [mistakes] a boat for one of the other sex."

As to the *facts*, which may be—it is well to note—"*inferred from what is reported*," we find enumerated among them the external characters of the sea-serpent, its dimensions, form, and skin. Of its internal characters "it is not astonishing that we don't know much," yet it is clear "that if the animal opens its mouth there

is an opportunity to learn something about its teeth, tongue, &c.," and so we get a series of "inferred" facts about them. We have further details of its colours, sexual differences, a very full account of its "physiological characters," some of its "psychical characters," concluding with its enemies, its repose, its sleep, and its death.

Enough has been written to prove that this volume is not without a certain amount of interest. We have found it a rather troublesome task to read it through, but to open its pages at random one is sure to be arrested by some startling phase of belief or by some marvellous narration, and the first half of the book very certainly deserves to be described as a conscientious compilation. It is written in most excellent English.

PUBLIC HEALTH.

A Treatise on Public Health and its Applications in Different European Countries. By Albert Palmberg, M.D., Medical Officer of Health for the County of Helsingfors in Finland. Translated from the French edition, and the section on England edited by Arthur Newsholme, M.D. (Lond.), D.P.H., Medical Officer of Health for Brighton. (London: Swan Sonnenschein and Co., 1893.)

ALTHOUGH scarcely more than a year has elapsed since the issue of the Swedish edition of this work, translations of it have already appeared in French, English, and Spanish. A book which within so short an interval has attained to such a pitch of popularity may be admitted to have practically established its claim to rank amongst the important contributions towards the literature of the subject with which it is concerned. Extensive indeed as is the ground travelled over by the author, yet so ably has the material been handled, that we feel it to be a matter for regret that the writer was unable to deal with the hygienic administration of all, instead of a portion only, of the important European countries. The sanitary administrations of England, Scotland, France, Germany, Austria, Sweden, and Finland are detailed; but the description of the Public Health service of Russia, Denmark, Norway, Holland, and Italy is omitted. Not having visited these countries, and studied the subject by a personal inquiry on the spot, Dr. Palmberg very wisely preferred not to deal with them at all, rather than run the risk of making inexact statements concerning them

In treating of the various countries, the plan which the writer has followed has been first to give a brief summary of the sanitary laws in force, and then to describe in detail the methods adopted in the capital towns for carrying out these regulations. Of all countries England claims the largest share of attention, Dr. Palmberg assigning to her the chief place amongst the nations for the excellence of her Public Health administration, and the care with which all matters connected with hygiene are attended to. The chapter on England contains a good *résumé* of our principal sanitary laws, together with a summary of the model bye-laws of the Local Government Board. The description of sanitary apparatus is excellent, the text being plentifully supplied with illustrations. Notwithstanding the limited space which is allotted to each country, the author is nevertheless able to introduce a mass of detail relating to practical sanitation which we believe would be looked for in vain even in our standard text-books on hygiene. We may instance as examples of this the paragraphs on the scavenging of London, and the disposal of rubbish and street refuse; the description of the preventive measures adopted in this country for the limitation of the spread of infectious disease, together with an account of the ambulance service and hospital ships; the explanation of the methods adopted for the ventilation of some of our important public buildings; the excellent *résumé* of school hygiene, for which we have no doubt the author is deeply indebted to Dr. Newsholme; and the summary on industrial hygiene, although the author is rather inclined to repeat many of his remarks under this head when describing "the sanitary provisions as to industries." Dr. Palmberg's admiration of English sanitation is pronounced, and in commenting on our appreciation of the beneficent results of good ventilation, we find him giving vent to the quaint statement that "even in cold weather the windows of high houses are opened, children and adults without fear of chill breathing the pure air"!

France, the author informs us, has no general sanitary law, most of the sanitary regulations in force consisting of ministerial decrees, orders of prefects and councils of health. Corresponding to this laxity of sanitary control, the great sanitary improvements which have been from time to time introduced have not been followed in Paris by a continuous fall in mortality, as in the case of the other European capitals. As the author very rightly remarks, the time is past when it can be supposed that good sense and administrative capacity merely suffice for the regulation of the Public Health. The drainage of Paris is exhaustively treated, the sewerage of the town being dealt with in detail, the writer in the course of his description pointing out that the system in use is objectionable, inasmuch as it allows deposits of sand to occur, and necessitates the maintenance of an army of 850 men to keep the sewers clear, the workers themselves at the same time having a relative mortality from typhoid fever twice as great as that for all Paris. Moreover, owing to the friction of the enormous deposits of sand in the sewers the wear and tear on the latter are great, and compel frequent repairs.

The sanitation of Germany and Austria is dealt with in the same thorough spirit as pervades the rest of the book and calls for no special remark.

In the description of the general regulations in force in Sweden relating to hygiene in towns, we think, however, that these laws might with advantage have been more systematised, much after the plan that the writer has adopted in dealing with Finland.

The translation is remarkably well done, and with one exception is quite free from the sort of mistake usually met with in English editions of foreign works. The instance we refer to occurs on page 380, where the author, in describing the forms of stove ordinarily employed in Germany, makes use of the following words:—"Although the construction differs from that of the English ventilating stoves *made by Douglas Galton* and Boyle and Son."

Dr. Palmberg's book is undoubtedly a valuable one, and should prove of the utmost utility to all interested in

sanitary science. By placing in our hands a description of the Public Health systems in vogue amongst continental nations, it allows us the opportunity of comparing them with our own, and correcting our shortcomings by their experiences. Notably should this be the case in our methods of food inspection. H. BROCK.

OUR BOOK SHELF.

The English Flower Garden: Style, Position, and Arrangement; followed by a Description of all the best Plants for it, their Culture and Arrangement. By W. Robinson. Third Edition. (London: John Murray, 1893.)

THIS quite recently published new edition of this most charming and useful book has been so completely altered as to be at first sight scarcely recognisable, and we are glad to record that all these alterations have been improvements, the result of a determination on the author's part never to give up the effort of making it better. In the present edition the old plates, many of which contained but feeble portraits of plant life, have been broken up, and in their places we find delightful pictures of some of our best loved flowering shrubs and plants, at one time represented as growing over walls or cottage porch, or again by the lake or riverside. All of these are perhaps not equal in execution, but it has seldom happened to us to see so large a number of illustrations with so few that are below a high standard. Such delightful woodcuts as those of the double flowering hollyhock, the Alpine pink, or of *Rodgersia podophylla* brighten up the pages and add much of interest to this book. So familiar is this volume to most lovers of plants, of which the fact of three editions within ten years is a satisfactory proof, that it seems almost needless to explain that the first portion of it is devoted to a series of chapters on such subjects as design and position of a garden, on the wild garden, the Alpine garden, on spring, summer, and autumn flowers, and we note even on "Pergolas," the illustration of this latter being from Venice. Alas! in these northern countries our sunshine scarcely ever needs a shade. The whole of the first portion of the book is rewritten, and many new illustrations are given, such as the "primrose garden in a small clearing of a birch wood" in Surrey, the group of "Solomon's seal at the foot of a wall," and others too numerous to mention.

The second and much larger portion is devoted to a list, arranged in alphabetical order, of all those plants that have been grown successfully in the gardens of Great Britain and Ireland, and of some few that may be expected to grow there. Like the rest of the volume, this part too has been very thoroughly revised and brought up to date. To every one in the possession of a garden, or having the care of one, we would say study this "English Flower Garden," for you cannot do so without profit.

Logarithmic Tables. By Prof. George William Jones. (London: Macmillan and Co., 1893.)

THIS book of tables, which we notice has reached its fourth edition, will be found to serve the purpose for many computations which require an accuracy extending only to four or five places of decimals. The tables throughout seem to be well arranged, and the figures neatly printed, thus fulfilling two important requirements from the computer's standpoint. In addition to five-place logarithms there is a table to four-places, together with four-place trigonometric functions, a table of useful constants, and an addition-subtraction table. Among others we may mention a five-place table of natural sines, &c., with a six-place table of their logarithms, prime and composite numbers, squares, cubes, square roots, &c., Bessel's coefficients for interpolation to the fifth differences, binomial coefficients for interpolation, also for fifth differences, and lastly a useful table of the errors of observations, from which we can at a glance determine the ordinates of the probability curve, values of probability integrals, &c. An explanation, preceding the tables themselves, shows how they may be advantageously used, and the author offers the reward of "a dollar" for the first notice of a mistake "to promote the detection of errors."

Catalogue of the British Echinoderms in the British Museum (Natural History). By F. Jeffrey Bell, M.A. (London: Printed by Order of the Trustees.)

DURING recent years many additions have been made to the collection of echinoderms in the British Museum; and, as Dr. Günther explains in his preface to the present volume, much time and labour have been given to the study and arrangement of these additions. It seemed expedient, he says, to prepare, together with the nominal list of the specimens, a complete account of the species hitherto found in British seas. All students of the subject will congratulate themselves on the fact that this decision was arrived at, for the result is that they are now provided with a handbook which will enable them to identify, without much difficulty, any specimens that may come in their way. Mr. Bell, in beginning the preparation of so full a catalogue, had before him a task of no small difficulty, and in the manner in which he has discharged it he has displayed great patience, insight, and knowledge. A number of well-printed plates add largely to the value of the work.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Hatching of a Peripatus Egg.

IN NATURE, vol. xliv. p. 468, I briefly described some eggs of the larger Victorian *Peripatus*, which were laid by specimens kept alive by me in the winter (Australian) of 1891. At that time, following previous authority, I identified the species which laid the eggs as *P. leuckartii*. It appears now, however, that the real *P. leuckartii*—at any rate, in New South Wales—is undoubtedly viviparous, and our oviparous Victorian species is, therefore, probably distinct. (It may be remembered that in NATURE, vol. xxxix. p. 366, I suggested this probable distinction on account of the remarkable pattern of the skin usually exhibited by the fifteen-legged Victorian form.) Further particulars on this subject are given in my "Further Notes on the oviparity of the larger Victorian Peripatus, generally known as *P. leuckartii*,"[1] and in the literature cited therein. In that paper I described two embryos, removed from eggs which had been laid for about three and eight months respectively. In the latter case I showed that the embryo was possessed of the full number of appendages, and was in all respects a perfect young *Peripatus*, differing externally from the adult only in the smaller size and less deeply pigmented skin. On the strength of these observations I claimed to have definitely proved that the larger Victorian *Peripatus* at any rate sometimes lays eggs, and that these eggs are capable of undergoing development outside the body until perfect young animals are produced. I am now able to add some further information.

For some time only one egg (belonging to the original lot, for none have since been obtained) remained in the hatching box. The shell of this egg had changed to a dark brownish colour, and latterly an embryo had been visible through the shell, coiled up inside. The egg was lying on a small piece of rotten wood, which rested on the glass floor of the hatching box. On

1 "Proceedings of the Royal Society of Victoria," vol. v. p. 27; also *Annals and Magazine of Natural History*, 1892.

January 3, 1893, not having opened the box for some days, I made an examination. The egg was in its former position, so far as I could tell, but the shell was split on one side and the young *Peripatus* had escaped. This young *Peripatus* was found lying dead on the glass floor of the hatching box, 25 mm. distant from the shell. It must have crawled off the rotten wood and along the glass to the position in which it was found. It was only about 5 mm. in length, so that, even assuming that it moved in a perfectly straight line, it must have crawled for a distance five times its own length. To the naked eye the young animal appeared of a pale greenish colour. It could not have been dead for very many days, but decomposition had already set in, and the animal was stuck to the glass on which it lay. It was impossible to remove it without considerable injury, but I ultimately succeeded in mounting it in Canada balsam, and it is impossible, even in its present condition, to doubt that it really is a young *Peripatus*, for the characteristic jaws and claws are well shown. I also mounted the ruptured egg-shell, and found that the characteristic sculpturing on the outside was still clearly visible.

This egg, then, hatched out after being laid for about seventeen months (from about July 1891 to about the end of December 1892). I cannot believe that under natural conditions the embryos take so long to develop. At any rate it now appears certain that the larger Victorian *Peripatus* lays eggs which may hatch after a lapse of a year and five months.

ARTHUR DENDY.

The University of Melbourne, February.

A Simple Rule for finding the Day of the Week corresponding to any given Day of the Month and Year.

A RULE was lately mentioned to me by a friend for finding, almost by inspection, the day of the week for any given year and day of any month in that year, during the present century. The basis of the rule is so obvious, when once the rule is stated, as to require no demonstration, but it struck me as so ingenious as to be worth while communicating it to you in case you deemed it worthy of insertion. I also append a very easy method of extending the rule to any date subsequent to the introduction of the Julian intercalation either in the past or future, except indeed for the eighteenth century, in which the introduction of the new style requires a special treatment.

The nineteenth century rule above alluded to is this. Each of the 12 months has its special numerical constant, thus:—

Jan.	Feb.	Mar.	Ap.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
3	6	6	2	5	0	2	3	1	3	6	1

Write down four columns thus

A | B | C | D

Under A enter day of month, under B constant for that month, under C year of century, under D greatest multiple of 4 in the year of century.

Add together the numbers under these heads, divide by 7, and the remainder is day of week; except that in Leap Year 1 must be subtracted for any day before February 29.

Example.—June 18, 1815 (Battle of Waterloo):—

A	B	C	D	Sum.		Remr.	
18	0	15	3	36	$\frac{36}{7}$	1	Sunday.

February 1, 1892:—

A	B	C	D	Sum.		Remr.	
1	6	92	23	122	$\frac{122}{7}$	3	Sunday

Subtract 1 for Leap Year before February 29. *Ans.*—3 − 1 = 2 or Monday.

December 25, 1892:—

A	B	C	D	Sum.		Remr.	
25	1	92	23	141	$\frac{141}{7}$	1	Sunday.

To extend the rule to any future century, we have only to alter the monthly constants, adding 5 to each for each added century after the present, and 1 for each century, an exact multiple of 4, in the interval.

Thus for the thirty-first century. Number of added centuries is 12, and there are 3 centuries, succeeding multiples of 4 (twenty-first, twenty-fifth, and twenty-ninth). Therefore add 5 × 12 + 3 = 63, or omitting multiples of 7, add 0.

Hence, constants for thirty-first century are the same for the present century.

New Year's Day, 3001,

A	B	C	D	Sum.	Remr.	
1	3	1	0	5	5	Thursday.

For centuries anterior to the eighteenth we must first of all find by special method what the monthly constants would have been throughout the eighteenth century without the change of style, and then subtract 6 for each century short of the eighteenth.

It may easily be seen that the constants throughout the eighteenth century would have been without change of style.

Jan.	Feb.	Mar.	Ap.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
2	5	5	1	3	6	1	4	0	2	5	0

For the eleventh century subtract 7 × 6 or 42, *i.e.* since this is multiple of 7 subtract 0, and we get the same repeated.

For the seventeenth subtract 6, and remember that when the result is negative we must replace it by the defect of the corresponding positive number from 7, and we get

3 6 6 2 4 0 2 5 1 2 5 1

Example.—Battle of Hastings, Oct. 14, 1066.

A	B	C	D	Sum.	Remr.	
14	2	66	16	98	0	Saturday.

Execution of Charles I., Jan. 30, 1649,

A	B	C	D	Sum.		Remr.	
30	3	49	12 =	94	$\frac{94}{7}$	3	Tuesday.

H. W. W.

"Roche's Limit."

WITH reference to Prof. G. H. Darwin's notes (NATURE, March 16, p. 460) on the investigations of M. Roche as to the smallest distance from its primary at which a satellite can exist, does not the distance given—viz. 2·44 times the radius of the primary—refer to the case of the satellite having the same density as its primary? In Note 3 Prof. Darwin warns the reader that Roche's limit depends, to some extent, on the density of the planet. Suppose the density of the planet to remain the same while that of the satellite is taken at double. In this case the tidal or differential influence of the planet on the two halves of the satellite will have doubled, while the gravitational attraction of the two halves of the satellite on each other will have become fourfold; and generally, the power of the planet to pull the satellite asunder will be inversely as the density of the satellite, and directly as the density of the planet.

An alteration of the size of the satellite does not much affect the question, because both forces are thereby equally altered, so long as the satellite is very small in comparison with its distance from the planet.

Seeing that the tidal or differential influence of a planet on its satellite is inversely as the cube of their distance apart, perhaps it would be correct—as far as gravitational influence alone is concerned—to state the limit at which a satellite can exist as being equal to $2{\cdot}44\ R \times \left(\frac{D}{d}\right)^{\frac{1}{3}}$

where R = the radius of the planet,
D = the density of the planet,
d = the density of the satellite.

As an interesting case of the same problem from a different point of view, suppose two very small equal spheres in contact, and a third much larger sphere placed in line with their centres, all three having the same density; then, when the distance of the point of contact of the small spheres from the centre of the large one is 2·52 times the radius of the large one, the attraction of the two small spheres for each other just balances the differential influence of the large one tending to draw them asunder. The effects of variation in density and size being the same in this case as in the former.

It would probably be interesting to many of your readers to have Prof. Darwin's views as to whether it is a reasonable supposition that a small satellite, such as Jupiter's fifth, is likely to have the same density as Jupiter; and whether the meteorites forming Saturn's ring are likely to be of so small density as

Saturn; as it would appear that without making some such supposition, no definite limit can be fixed.

Applying this supposition to the sun, with reference to meteoric swarms, we have 2·44 times the sun's radius, taken at 433,000 miles, or 1,056,520 miles as the distance at which the sun would prevent the meteors coalescing to form a planet. In Note 3 Prof. Darwin states this at one-tenth of the earth's distance from the sun, probably by inadvertence. G. R.

The Ordnance Survey and Geological Faults.

In view of the re-survey of the United Kingdom, it seems to me that if the officers of the Survey were directed to take special notice of the levels of the former survey on both sides of great geological faults, and to compare these levels now so as to ascertain if any appreciable relative change had taken place during the forty or fifty years since the first survey, valuable information as to the motion of these faults, if any, might be obtained.

This idea is mainly suggested to me by the fact that in this neighbourhood a great fault intersects the Old Red Sandstone close to its contact with the Highland schists, it has been traced from Stonehaven on the east coast to Loch Lomond on the west, and seems to give remarkable evidence of being, at least to a certain extent, in motion. The village of Comrie, famous for its "earthquakes," is situated on this fault, and the "earthquakes" are as lively as ever. In the valley of Strathmore farmhouses placed in the proximity of this great dislocation are, or were, celebrated for being "haunted," on account of the noises and tremors by which the inhabitants are from time to time alarmed.

Most, if not all, British "earthquakes" have been, I think, wisely attributed to similar causes.

Of course fifty years is a very minute part of the history of one of these old faults, but if the data of the Ordnance Survey be so accurate as is usually supposed, some trace of shifting might possibly be discovered if the necessary observations were made.

Newport, Fife, March 18. Jas. Durham.

The Discovery of the Potential.

Mr. E. J. Routh has lately published a most valuable "Treatise on Analytical Statics." I quote from the second volume, p. 17, the following note:—

"The earliest use of the function now called the potential, is due to Legendre in 1784, who refers to it when discussing the attraction of a solid of revolution. Legendre, however, expressly ascribes the introduction of the function to Laplace, and quotes from him the theorem connecting the components of attraction with the differential coefficients of the function. The name, Potential, was first used by Green," etc.

From this note it appears that the discovery of the potential must be attributed to Laplace. This is a wrong opinion, and some fifteen years ago Baltzer proved that the introduction of the function is due to Lagrange ("Zur Geschichte des Potentials," in *Journal für die reine und angewandte Mathematik*, vol. lxxxvi. p. 213, 1878). Some historical documents in favour of Lagrange's priority have been found, by the writer of these lines, in Todhunter's "History of the Mathematical Theories of Attraction and the Figure of the Earth," and collected in a note at the end of vol. i. of his work, "Il Problema Meccanico della Figura della Terra" (Torino, 1880), where a full account of the early history of the potential is given, with numerous bibliographical indications. Ottavio Zanotti Bianco.

Private Docent in the University of Turin,
March 21.

The historical note on p. 17 of my "Statics" is chiefly founded on the statements in Todhunter's "History," and in Thomson and Tait's "Natural Philosophy." The references to these two writers are given in the note. Both Dr. Todhunter and Lord Kelvin ascribe the introduction of the function for gravitation to Laplace, and assert that the name of "Potential" was first given to it by Green. My own reading, though not so extensive as theirs, had not led me to form any different opinion. In Nichol's "Cyclopædia of the Physical Sciences" the first introduction is given as due chiefly to Legendre, Lagrange, Laplace, and Poisson. In Chambers's "Cyclopædia" Laplace's name alone is mentioned. Baltzer, as cited by Mr. Bianco, mentions the use of the function by Lagrange in the *Mém. de Berlin*, 1777. This is earlier than the memoir of Legendre, but as Legendre assigns the introduction of the function to Laplace, it is difficult to compare the dates. I am at present unable to refer either to the memoir of Lagrange or to the treatise of Mr. Bianco.

E. J. Routh.

Van't Hoff's "Stereochemistry."

The review of the above by "F. R. J." in Nature, p. 436, raises some important points in connection with this peculiarly fascinating branch of chemical science. In referring to the recent ingenious and attractive theory of P. A. Guye, that the numerical value of optical activity is dependent upon the relative masses of the four groups attached to the asymmetric carbon atom, and which carries with it the corollary that if two of these four groups are of equal mass the rotatory power will cease, your reviewer states that Guye "was unable to verify this view in all strictness." I think, however, that he hardly emphasises sufficiently that this important corollary has in every case, when put to the test of direct experiment, broken down. As far as I am aware, there is not a single instance of an asymmetric carbon atom attached to four groups *qualitatively distinct*, being found optically inactive in consequence of two of those groups being *quantitatively equal in mass*. Indeed some such substances are not merely active but powerfully so. The reviewer considers that this inadequacy of Guye's theory is palliated by the alleged fact that the amount of rotatory power of the esters of an active acid is determined by the weight of the alkyl-group. This point, which is one of the cardinal pillars of Guye's theory, I have recently put to the test of actual experiment, by measuring the rotatory power of a number of the esters of active glyceric acid, which have been prepared by Mr. J. MacGregor and myself. In this investigation we found the most extraordinary verification of Guye's theory, as far as the optical properties of the normal series of methyl, ethyl, and propyl glycerates were concerned; with the appearance of isomerism, however, this regularity ceases, thus the isopropyl glycerate has a markedly lower rotation than the normal one, whilst the normal and secondary butyl compounds have a lower rotation than the isobutyl ester. Nor are these differences consistently explicable by taking into consideration the interatomic distances, as measured by atomic volume, for the molecular volume of the normal propyl glycerate with its greater rotation is less than that of the isopropyl compound with its smaller rotation, whilst the molecular volumes of the isobutyl and secondary butyl glycerates are almost exactly equal, although the rotation of the former is much greater than that of the latter.

The reviewer, in referring to the rotation exhibited by the salts of active acids, states that in the case of tartaric acid all the salts "display in solution the same rotatory power, irrespective of the atomic weight of the metal," and is apparently satisfied that "the clue to this anomaly is furnished by the electrolytic theory of Arrhenius," according to which "it is the ion $CO_2(CHOH)_2CO_2$ which is alone responsible for the rotation." The reviewer has in this endorsed the method of special pleading adopted by the advocates of this theory, in which the metallic tartrates have been summoned as witnesses, whilst only the testimony of those favourable to the theory has been admitted. Thus one of the commonest of the metallic salts of tartaric acid—tartar emetic—has a rotation which differs entirely from that of the other tartrates, and thus conclusively negatives the dogma that the rotation of the solutions of metallic salts is independent of the particular metal which has replaced the hydrogen of the acid. Fresh light has been thrown on this point in the course of an investigation, which I have recently carried out with Mr. Appleyard on the rotatory power of the metallic salts of active glyceric acid, and which has shown that the specific rotatory power of the glyceric acid has one value when deduced from the rotations of its alkaline salts (lithium, ammonium, sodium, and potassium), another value when deduced from the salts of the alkaline earths (calcium, strontium, and barium), and a third from the salts of the magnesium group of metals (magnesium, zinc, and cadmium). Now it so happens that almost the only salts of tartaric acid which have had their rotation determined are those of the alkaline metals, which also in the case of glyceric acid yield practically the same rotation. Hence if only the rotations of the alkaline glycerates had been determined, the same erroneous conclusion would have been arrived at concerning the rotation of glyceric acid. Whatever may be the ultimate interpretation put upon these new results, and I prefer for the present to ab-

stain from any generalisations, it is obvious that the notion of the rotatory power of saline solutions being independent of the particular metal present in the salt is altogether untenable.

PERCY F. FRANKLAND.

University College, Dundee, March 11.

THE notice referred to by Prof. Percy F. Frankland was written, and the proof returned to the printer, before the end of last year. Since then two researches have been published —by Purdie and Walker, and by Frankland and Appleyard—in which facts are adduced, apparently irreconcilable with Guye's theory. Had these facts been at my disposal I should doubtless have expressed myself more guardedly.

Prof. Frankland says: "As far as I am aware, there is not a single instance of an asymmetric carbon atom attached to four groups *qualitatively distinct*, being found optically inactive in consequence of two of those groups being *quantitatively equal in mass*;" and he complains that I have hardly emphasised this sufficiently. My reason was, that I was not altogether convinced of the fact, as may be seen from the following passage, which I transcribe, and which originally formed a footnote to the notice in question:—

"The present reviewer ventures to suggest that cases such as are sought by Guye are to be found in those compounds in which two of the four different groups attached to an asymmetric carbon atom are themselves asymmetric carbon atoms of equal and opposite enantiomorphism. Such compounds would exist in two distinct forms; but as the two opposite enantiomorphic groups would be of equal mass and would be situated at equal distances from the central asymmetric carbon atom to which they are attached (inasmuch as the two opposite enantiomorphic modifications of a compound always have the same molecular volume), the conditions necessary for optical inactivity according to Guye's theory would be fulfilled, and neither of the two forms ought to cause rotation of the polarised ray. Such a case has already been observed in the two inactive, non-racemic trihydroxyglutaric acids described by Emil Fischer (*Ber. der deutsch. chem. Ges.* 24, p. 4214), although it does not appear to have been hitherto interpreted from this point of view."

I afterwards suppressed this footnote, partly because it seemed to me out of place in such a notice, and partly because the optical activity of the two trihydroxyglutaric acids could be accounted for in another way: namely, by the fact that, as pointed out by E. Fischer, the mirror images of their molecules are congruent with the molecules themselves. But the passage will show why I was indisposed to enter a proved negative against Guye's theory.

As regards the charge of "endorsing special pleading" in the interests of the electrolytic theory of Arrhenius by suppressing the fact that tartar emetic has, in solution, a different rotation from the other metallic tartrates, I may say at once that I was ignorant of this fact. I am not a specialist on the subject of the optical properties of organic compounds, and I merely summarised, doubtless uncritically, the account of Oudemans' law given in van't Hoff's book. Indeed, the brief notice, as its wording everywhere indicated, was a summary rather than a criticism.

I take this opportunity of rectifying an omission. At the time of writing the notice I was not aware that Prof. Crum Brown had, independently of M. Guye, put forward, in the Proceedings of the Royal Society of Edinburgh, views on the influence of the various substituting radicles in modifying the optical rotation of organic compounds.

F. R. JAPP.

University of Aberdeen, March 18.

Standard Barometry.

THE question of absolute accuracy in barometer readings is one of great importance to meteorologists; but there has been so much uncertainty shown by the accumulated facts relating to the subject, that I think that no one who has carefully studied the matter has felt fully satisfied that strictly comparable international standards had been obtained. An uncertainty of at least 0·1 mm. was indicated by the various international comparisons of normal barometers which have been carefully made and discussed during the past ten years. I think that at last a definite conclusion has been reached, and that the very recent results published in paper No. 4, Band xvi. of the *Repertorium für Meteorologie* will be accepted as proving that at St. Petersburg at least normal readings are obtained.

About twenty-five years ago Director Wild, of the Central Physical Observatory at St. Petersburg, established the first normal barometer of the *modern* form; and as much as twenty years ago he claimed to have obtained practically normal readings. Moreover, he urged that the transfer of these normal readings from place to place by means of portable barometers was impossible within the desired limits of accuracy, and that each country ought to have its own thoroughly investigated normal barometer. This last has been proved by the results obtained by various investigators; and now Prof. Wild offers the proof of the accuracy of his normal barometer in the paper just referred to, which bears the title "Die normal-barometer des Physikalischen Central-Observatoriums zu St. Petersburg."

This paper was presented to the Academy of Sciences on November 4, 1892, and in it Wild gives the results of the intercomparison of three local normal barometers.

Normal barometer No. I. was mounted at St. Petersburg in 1870, and was fully described in Band iii. of the *Repert. f. Meteor.*

A second normal barometer was mounted at Pawlowsk (about twenty miles from St. Petersburg) in 1887, and a third normal was mounted at St. Petersburg in 1891, and is known as normal No. II.

In 1887 and 1888 Wild found that the St. Petersburg normal I. and the Pawlowsk normal did not differ by more than 0·01 mm.

In 1892 the St. Petersburg normals I. and II. were found to agree within the limit of error of observation (less than 0·01 mm.).

In 1892 the St. Petersburg Normal II. was dismounted, taken to Pawlowsk, and there compared with the Pawlowsk normal, and the two were found to differ by only 0·01 or 0·02 mm.; that is ·004 or ·008 inch. It must be added that these comparisons have all been checked by means of comparisons with portable barometers of the highest class.

The paper by Prof. Wild is accompanied by illustrations of these various normal barometers. The St. Petersburg normal has recently undergone some alterations, and these are also fully described. Altogether this is perhaps the most important contribution to the subject that has appeared since Prof. Wild's famous memoir of 1873; for we can now rest assured that farther refinement is not required by any practical demands.

It seems to me that now that we are sure of the accuracy of Wild's normal, it is more necessary than ever that we should know with greater certainty its relation to the principal standards of Europe. I desire, therefore, to propose a plan by which a series of comparisons can be carried out for a few places at a very slight expense, and with as much accuracy as portable instruments will permit. In 1883 it became my duty to transport to America, from Hamburg three of the Wild-Fuess portable barometers of the highest grade; and it was of great importance to take every possible precaution against their being injured or their condition altered in any way so as to affect their readings. I devised a mounting on shipboard which was very satisfactory, and gave me no cause for uneasiness regarding the barometers, even in stormy weather. So many barometers are sent out from England to almost every country that I strongly urge the use of a similar arrangement in all cases where it is desirable to retain an assigned barometer correction.

The accompanying sketch shows my manner of mounting the barometers. Two small strips of wood, AA, are screwed to the woodwork running lengthwise of the vessel. They are placed about two feet apart, and are inclined at an angle of perhaps 45°. Small leather straps, say 15 inches long, are fastened to these strips by single screws as shown at BB. A rather soft stuffed flat cushion or pillow is now placed against the woodwork (wall) as shown at C. The box containing the barometer is now pressed against the cushion and the two extremities are placed within the grasp of the straps BB. These last are buckled and drawn tight enough to hold the barometer box firmly against the cushion C. The barometer is thus held in such a manner that no ordinary jarring can cause any damage to it, as there is no direct contact with a rigid surface, since the pillow prevents it from touching the wooden strips, and the soft yielding straps have a spring-like effect.

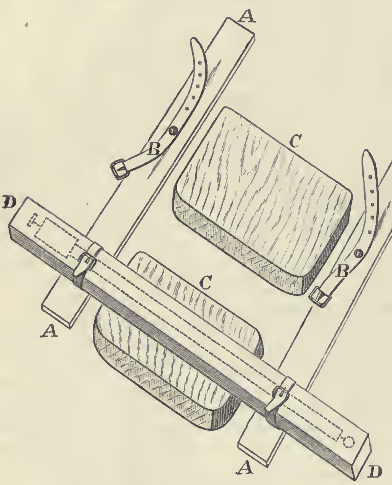
The lower part of the sketch shows the barometer box DD in position, with the barometer shown within it. Of course the cistern is held uppermost. On account of the jarring motion of the ship's screw in rough weather, it is desirable to locate the barometers well amidship, and also have the cistern of the baro-

meter directed towards the stern. Barometers can be placed in this manner on ship board by the maker, and can be left to themselves for any length of time. If the person to whom they are consigned is notified of their subsequent arrival at port, he can take them from their hangings on the ship in the best possible condition. Of course this presupposes an arrangement with the officers of the vessel, such that the instruments shall be let entirely alone from the time they are mounted by the consignor until they are received by the consignee.

I think this method of carrying instruments can be very usefully applied in improving our knowledge of the relation of international barometric standards, and at a minimum expense; and I will give a brief outline of a convenient way for accomplishing it. The Deutsche Seewarte at Hamburg, and the Kew Observatory at Richmond (through the London Meteorological Office), are in the best positions for supervising this work, and I venture to express the hope that the matter will be seriously considered.

I will outline the work when carried on from London.

Let two barometers of the best construction, say an Adie Fortin and a Wild-Fuess control barometer, be compared with the Kew normal during a period of a week or more, or long enough to experience considerable variation in the barometer



height. Then let the two barometers be mounted on one of the London Hamburg steamships, in the manner which I have described, and sent to Hamburg, where an employee of the Deutsche Seewarte could be despatched to take down the instruments and carry them to the Seewarte for comparison with the normal barometer. Then the barometers could be taken by a messenger to Lübeck, at an expense of a few shillings, and mounted on a St. Petersburg steamer, which would carry them almost to the door of the Central Physical Observatory, where they could be again taken in charge by a meteorologist, compared for a few days, and then again be mounted on another steamer bound for one of the Scandinavian ports where there is a standard barometer, and finally returned to London by one of the numerous regular steamships. At an expense of a couple of pounds the barometer could be sent from St. Petersburg (or Scandinavia) back to Hamburg *viâ* Stettin and Berlin; thus allowing Berlin to enter into the series. The barometers would probably have to be sent by a messenger from Berlin to Hamburg, thus entailing the just mentioned expense. A second comparison at Hamburg would be desirable, and then the barometers could be returned to London by sea, and again compared at Kew.

Similarly, barometers could be sent to New York for comparison with the sub-standard, by Adie, at the Maritime Exchange; although probably the United States Weather Bureau would assume the expense of the three pounds necessary to carry the instruments to Washington for comparison with the normal there, and then return them to New York and put them on shipboard to be returned to London.

The standard barometers of Australia, India, Brazil, and other countries accessible by sea can be reached from London (or Hamburg) in the same way, and the comparison instruments can be returned to their starting point for additional verification.

My own experience in the transportation of barometers assures me that ship captains would gladly give their hearty co-operation to a work of this kind, and there would be no charges for carrying the instruments even half round the world and back again.

In offering this suggestion it is not necessary for me to give the details for the complete organisation of such a scheme; but it may be remarked that if it should be undertaken, the personal experience of those who have been over the ground should be utilised in making plans. A single instance will serve to show why this is advisable. Some years ago I carried two barometers from Hamburg to London by sea. I took the German line of steamers and found myself anchored in the middle of the Thames, and had to get ashore as best I could. I greatly feared that I should never get the barometers ashore in a whole condition, as there was necessitated a great deal of scrambling over lighters, &c., and embarkation in an unsteady row boat in order to make a landing. Had I taken the English steamer, all this worry would have been saved. Other similar instances occurred which could have been avoided by one personally familiar with the routes to be travelled. FRANK WALDO.

Princeton, New Jersey, February 20.

Motion of a Solid Body in a Viscous Liquid.

THERE is perhaps no branch of mathematical physics which has made greater progress during the last thirty-five years than hydrodynamics. During this period numerous important investigations have been published upon the motion of solid bodies in a *frictionless* liquid, upon the theory of discontinuous motion, upon the theory of vortex motion and vortex rings, upon the motion of a liquid ellipsoid under the influence of its own attraction, and upon waves and tides. These investigations constitute an enormous increase in the knowledge possessed by the present generation compared with that of its predecessors; they have to a considerable extent exhausted the field of research in the theory of the motion of *frictionless* liquids; but notwithstanding the importance of the results, the elegance of the methods by which many of them have been obtained, and the skill by which the mathematical difficulties have been surmounted, all the investigations referred to possess the defect of not accurately representing the motion of liquids as they occur in nature.

The reason of this discrepancy between theory and observation is that the ideal substance, which is called a *frictionless* liquid, has no actual existence, for all liquids which occur in nature are *viscous*. The viscosity of the mobile liquids, such as water, alcohol, &c., is a small quantity, being in the case of water equal to a tangential stress of about ·014 dynes per square centimetre; whilst in the case of the sticky and greasy liquids, such as treacle and oil, it is much greater. The viscosity of olive oil is about 3·25 dynes per square centimetre, and is therefore about 232 times as great as that of water.

The mathematical theory of the motion of viscous liquids was elaborated as long ago as 1845 by Sir G. Stokes, in a paper in which he showed that the effect of viscosity might be represented by certain additional terms in the equations of motion of a frictionless liquid, which contain as a factor a new physical quantity called the viscosity. In a subsequent paper, published in 1850, he applied the above theory to calculate the diminution of the amplitude of the small oscillations of a sphere surrounded by water; and by means of experiments in which this quantity was observed, he calculated the numerical value of the viscosity of water, and found that it was in close agreement with the value found by Poiseuille from experiments on the flow of liquids through capillary tubes. An investigation of a similar character was undertaken by von Helmholtz and Piotrowski about 1863, in which the sphere was suspended by a torsion fibre, and made to perform small torsional oscillations about a diameter.

Almost all calculations relating to small oscillations proceed upon the basis that the squares and products of quantities, upon which the disturbed motion depends, may be neglected. This introduces a great simplification into the work, and enables a variety of problems, which would otherwise be exceedingly intractable,

to be solved by fairly simple methods. There is, however, another class of problems of great practical importance, in which it is not allowable to neglect these quadratic terms, and towards the solution of such problems theory has as yet made little progress.

When a sphere is constrained to move along a horizontal straight line, but is otherwise free, it is well known that if the surrounding liquid is supposed to be frictionless, its only effect is to increase the inertia of the sphere by half the mass of the liquid displaced. The sphere accordingly requires a larger impulsive force to start it than if the liquid were absent, but when once started it continues to move with its velocity of projection. But when the sphere is surrounded by an *actual* liquid, its velocity gradually diminishes until it ultimately comes to rest; and this fact shows very forcibly the necessity of taking the viscosity of the liquid into account in problems of this character. I obtained a few years ago a mathematical solution, which shows that this effect must necessarily be produced by a *viscous* liquid, but the solution is an imperfect one, as mathematical difficulties compelled me to disregard the quadratic terms.

It is always a great advantage when the solution of a mathematical problem can be made to depend upon a *single* function which satisfies a partial differential equation and certain boundary conditions. This is always the case when a solid of revolution moves along its axis in a viscous liquid which is initially at rest, or has an independent motion which is symmetrical with respect to the axis. In this particular class of problems, the motion can be expressed by means of Stokes's current function in the following manner:—Let z be measured along, and r perpendicularly to the fixed straight line with which the axis coincides during the motion; let w and u be the velocities of the liquid in these directions; then:—

$$u = -\frac{1}{r}\frac{d\psi}{dz}, \quad w = \frac{1}{r}\frac{d\psi}{dr},$$

$$\left(\nu D - \frac{d}{dt} - u\frac{d}{dr} - w\frac{d}{dz} + \frac{2u}{r}\right)D\psi = 0,$$

where

$$D = \frac{d^2}{dz^2} + \frac{d^2}{dr^2} - \frac{1}{r}\frac{d}{dr},$$

and ν is the kinematic coefficient of viscosity.

So far as I am aware, no serious attempt has been made to obtain a solution of this equation in a suitable form, even when the solid is a sphere. The equation is well worthy of the attentive consideration of mathematicians; and although it is an intractable one, it must be recollected that a general solution is not required, but only a particular one which is suitable in the case of a sphere. It will be quite time enough to consider the possibility of obtaining solutions of a more general character, when the appropriate one in the case of a sphere has been discovered. It is also important to recollect that in most problems which are of practical interest, ν is a small quantity (about ·014 in C.G.S. units for water), and consequently an approximate solution in which ν is supposed to be small would meet the exigences of the case.

When a solid body is moving through a liquid, one of the boundary conditions is that the normal velocity of the solid must be equal to the component along the normal of the velocity of the liquid in contact with it. If the liquid is frictionless, this condition is the only one which has to be satisfied; but when the liquid is viscous, a further question arises as to the law which expresses the effect of the tangential stress exerted by the liquid upon the solid. When the motion is very slow (as in the case of problems relating to small oscillations) the experimental evidence is in favour of the hypothesis of *no slipping;* but when the velocity is considerable, the experimental evidence is not so satisfactory. The partial slipping which takes place under these circumstances must depend partly upon the nature of the liquid, and partly upon that of the surface in contact with it; and the tangential stress to which it gives rise is probably approximately proportional to the square of the relative velocity.

When the motion is symmetrical with respect to an axis, the stresses due to viscosity can be calculated as soon as the value of ψ is known, the resistance which the liquid exerts on the solid can be found, and the equation of motion written down and integrated. This process is, however, an exceedingly tedious one; but it can always be dispensed with in the case of a single solid by employing the principle of momentum. When the motion is not symmetrical with respect to an axis, it cannot be expressed in terms of ψ; but if the velocities of the liquid can be found from the hydrodynamical equations, the components of the linear and angular momenta of the liquid can be calculated, and by applying the principle of momentum to the compound system composed of the solid and the surrounding liquid, the equations of motion of the former can be obtained. Since the momentum of the system is obviously a function of the six coordinates of the solid, this principle furnishes a sufficient number of equations for the determination of the motion.

When there is more than one solid, the principle of momentum is insufficient to determine the motion; but if the velocities of the liquid in the neighbourhood of each solid could be found, the force and couple constituents of the resistance could be calculated, and the equations of motion of each solid written down. Lagrange's equations in their ordinary form cannot be employed, as viscous motion involves a conversion of energy into heat; but problems which can be solved by an indirect method can usually be solved by a direct one, and I feel confident that equations analogous to Lagrange's equations exist, by means of which the motion of a number of solids in a viscous liquid can be found without going through the above-mentioned process. A form of Lagrange's equations has already been discovered, which is applicable when the viscous forces depend upon a dissipation function which is expressible as a homogeneous quadratic function of the velocities; and the circumstance that a dissipation function also exists in the hydrodynamical theory, although it is expressed in a different form, furnishes additional grounds for believing in the existence of equations of this character. The discovery of such equations would constitute an important advance in the theory of viscous liquids.

A. B. BASSET.

SCIENCE IN THE PUBLIC SCHOOLS AND IN THE SCIENTIFIC BRANCHES OF THE ARMY.

ON Friday last Mr. Campbell Bannerman received a deputation on this subject in his room in the House of Commons. There were present Sir Henry Roscoe, the Head Master of Rugby School, the Principal of Cheltenham College, the Head Master of Clifton College, Sir B. Samuelson, Prof. Jelf, and Mr. Shenstone. Lord Playfair, Sir John Lubbock, and Sir Henry Howorth would also have been present, but they were prevented by other engagements. The following is a brief account of the proceedings:—

Sir Henry Roscoe, in introducing the deputation, said that he had introduced a deputation on this subject to Mr. Stanhope about five years ago, and that if the suggestions then made had been adopted the present deputation would not have been necessary. After some remarks which showed the injustice of the present system to the more scientific lads, he pointed out several methods by which this injustice might be removed.

The Head Master of Rugby, Dr. Percival, expressed his strong feeling of the importance of the subject alike to the service, the cadets, and the schools, and said he wished to see both modern languages and science duly encouraged; he thought they might both be made compulsory, as he believed that early education should rest on a wide basis, and that specialising should only be encouraged later. Alluding to the work in science done at the Royal Military Academy, Dr. Percival mentioned that he knew of one cadet who, owing to the absence of any higher teaching there at the earlier stages, was lately learning science which he, the cadet, was well fitted to teach.

The Principal of Cheltenham College, Mr. James, confessed that his own interests and convictions on educational matters were those of a linguist rather than those of a man of science; but practical experience showed him that the present system told most unfairly against scientific boys who entered Woolwich; science was being gradually edged out. Many other head masters of public schools felt with the deputation. He thought also that the present system tended to the disadvantage of the smaller schools, where science was often exceedingly well taught. He hoped that in making any changes the authorities would be careful to consider the interests of linguistic boys, and

would not add to the number of subjects taken up at entrance, for boys were already overburdened in their preparation.

The Head Master of Clifton College, Mr. Glazebrook, said that this was a question on which the public schools had a strong claim to be heard, since an increasing number of boys passed direct from them to Woolwich—the proportion last July being about four-fifths of all the candidates. But the discouragement of science was not so serious to the great schools as to the smaller and less expensive schools, where as a rule science is well taught, but not German. He thought it undesirable that these latter should be debarred from competition. It was not only by the assignment of marks that science was now discouraged, but also by the system of instruction. Boys who went up to Woolwich tolerably proficient in chemistry were put back to the elements, and at the end of their first year knew less than when they entered. Such boys were naturally inclined to complain that science at Woolwich was a farce, and to urge their friends at school to take up another subject which was treated more seriously.

Further remarks were made by Sir B. Samuelson, who especially advocated the encouragement of all types of boys from the public schools, by Prof. Jelf, and by Mr. Shenstone. Statements were made by the Director-General of Military Education and the Inspector-General of Fortifications; the latter officer emphasised the importance of German and of electricity, and said many cadets were markedly deficient in the latter subjects when they left Woolwich. In concluding, Mr. Campbell-Bannerman expressed his obligation to the deputation, and his sense of the importance of the matter brought under his notice, which would have his most careful attention.

It will be seen from this report that the position of cadets of scientific ability at the Royal Military Academy is, as we pointed out some time ago, far from satisfactory, and that this view is now not only held by men of science but also by many head masters and by distinguished members of the military profession, who on this and on other occasions recently have spoken clearly on the subject.

The main defects of the present system seem to be:—(1) That science and German, two subjects which ought to go hand in hand in the early education of officers of the scientific branches, are at present brought into distinct conflict; (2) that in effect so great a bonus is given to German in the course of work at the Royal Military Academy as to be likely very soon to drive science out of the entrance examination, and to a corresponding extent out of the public schools; (3) that the standard of work of the cadets in science, and particularly in electricity when they leave the Royal Military Academy, is lower than it ought to be in very many cases.

Of these defects the last, which is doubtless largely the outcome of the first two, is probably the most important, and it will never be remedied so long as the authorities cling to the idea that a sufficient knowledge of several branches of science can be given to the cadets, even when they are quite new to such studies, in the moderate amount of time that can be spared for them during the comparatively brief course of work at the Royal Military Academy. That this idea is wrong we have pointed out again and again. If those who are responsible for the education of the cadets at Woolwich really desire that the cadets shall attain to a higher standard in science, they must not only encourage the admission of lads of scientific ability, but they must either set apart much more time to such work at the Academy, and give opportunities for, and more encouragement to, advanced work on the part of those who take up the subject, and do well in it at the entrance examination; or, if the giving of more time to science at the Royal Military Academy is impracticable, as is very possibly the case, they must so alter the conditions of the entrance examination as to secure that the cadets shall learn their elementary chemistry and heat at school, and be able to devote their science work at Woolwich wholly to electricity, which is technically of such great importance to them, but to which at present they can only give a portion of their time.

By doing this the authorities of the Academy will not only advance the interests of the service, they will also avoid that discouragement of the more scientific cadets and of the teaching of science in schools which is admittedly a result of the present system as a whole.

In conclusion, we would urge strongly what was pointed out by Sir Henry Roscoe on Friday, that it is not merely scientific knowledge but scientific ability which is wanted, and that it is only by giving due weight to science at the entrance examination and afterwards that this can be secured.

CLIMBING PLANTS.[1]

THIS forms the fourth part of A. F. W. Schimper's "Botanische Mittheilungen aus den Tropen," and is devoted to the description and illustration of the various adaptations for climbing exhibited by native Brazilian plants observed on the spot. Following Darwin, the author distinguishes four different classes of climbing plants, according to the manner in which they climb; but his four classes are not quite the same. Darwin divided them into those having stems which twine spirally round a support; those which climb by means of irritable organs; those which climb by means of hooks; and those which climb by means of roots. Darwin's investigations, it will be remembered, were chiefly directed to the elucidation of the phenomena exhibited by twiners, and such plants as climb by means of tendrils. Schenck treats in a general way of all four classes of climbers; and his work is more in the nature of a text-book than an account of experimental research. He divides climbing plants into Spreizklimmer, Wurzelkletterer, Windepflanzen, and Rankenpflanzen, corresponding nearly to the hook, root, twining, and tendril climbers of Darwin and others. But the Spreizklimmer include all climbing plants that neither twine nor possess either irritable climbing organs or clinging roots, whether armed or unarmed. Thus the least organised of climbing plants are those having weak, slender, rampant stems and branches which grow up among other plants and rest upon them without any other means of support; whilst the most perfectly developed climbing plants are those provided with highly sensitive nutating tendrils, such as the Cucurbitaceæ and the Passifloraceæ. It is difficult to find an exact English equivalent for "Spreizklimmer," but "incumbent climbers" might be employed to designate this class. Twiners revolve with the sun, as the hop (*Humulus Lupulus*), or against the sun, as the scarlet-runner bean (*Phaseolus vulgaris*); but Schenck agrees with Darwin and other observers that they are not sensible to contact. It is only the plants classed as tendril-climbers that exhibit this property; and this irritability is developed both in caulomes and in phyllomes—that is in branches and in leaves, more or less modified for the purpose. In England there are only three woody climbers, namely: the ivy, a root-climber; the honeysuckle, a twiner; and *Clematis vitalba*, a leaf-stalk climber; but in Brazil, and in other tropical countries, they are exceedingly numerous, and present a great variety of adaptations to this end. Dr. Schenck, however, does not confine himself to Brazilian forms. He briefly reviews all the types that have come under his observation. Plants climbing by means of tendrils (irritable organs), conceived in the widest sense, are classified according to the organs, or parts of the organs, by means of which they climb. First he takes the leaf-climbers, which climb by means of

[1] "Beiträge zur Biologie und Anatomie der Lianen im Besonderen der in Brasilien einheimischen Arten." Mit 7 Tafeln. Von Dr. H. Schenck. (Jena: Gustav Fischer, 1892.)

sensitive revolving leaflets (*Fumaria*), by the petioles (*Clematis* and *Tropæolum*), by the tips of the leaves (*Tillandsia* and *Flagellaria*). Then come the leaf-tendril climbers proper, such as *Pisum sativum* and *Cobœa scandens*. But the almost peculiarly tropical branch-climbers, plants climbing by means of modified caulomes (branches or inflorescences), present the most singular forms. Dr. Schenck divides them into branch-climbers proper, which have elongated naked or leafy revolving branches clasping the branches of other plants; hook-climbers, which develop hook or claw-like supports; "watch-spring" climbers and thread-climbers. The grape-vine and passion-flower are classed under the last. The climbing organs of the "watch-spring" type are very curious. They are naked, attenuated branches, which roll up in one plane, forming a loose elastic spiral, between the coils of which the support is caught. The spirals usually thicken only at the point of contact, thereby effecting a firm hold of the support. Dr. Schenck does not enter deeply into the anatomy of climbing organs, though he states that differentiation of the tissues of sensitive organs only takes place after contact. The plates are all devoted to the illustration of the external morphology of climbing organs. A systematic list of genera containing climbing species is given, and there is also a chapter on the geographical distribution of climbing plants.

W. BOTTING HEMSLEY.

CLAPHAM JUNCTION AND PADDINGTON RAILWAY.

THE statement that appeared in the press towards the end of last week, that the promoters of this railway had applied to the committee who rejected the bill for permission to bring the subject again before the House of Commons did not represent the fact. What really occurred may be gathered from the following extract from the *Times* of Saturday, the 25th inst.:—

"It had been the intention of the promoters of the Clapham and Paddington Railway Bill to ask the committee, presided over by Sir J. Kennaway, to grant permission to have the bill recommitted, in order to meet the objections as to electric traction raised by the Royal College of Science and the City and Guilds Institute. After a private consultation with the chairman, it has been decided that the public application to this effect should not be made until some arrangement has been come to with the authorities of these institutions in the Exhibition Road, and until steps had been taken to find out whether they would agree to the substitution of cable for electric traction on that portion of the line coming within the radius of the scientific colleges. . . . ."

Even the preceding corrected statement rather represents the aspect which the promoters would like the matter to assume than the strict truth. For as a matter of fact it has been pointed out first that the passage of the electric locomotives and the train of iron-framed carriages running nearly due north and south within some 40 feet of magnetometers would stop all work, even if the motive power were a cable; secondly, that the vibration caused by the quick moving trains and by the slapping cable would be ruinous; and lastly, that no one but an over-sanguine company promoter would imagine that an electric railway with a fragment worked by cable in the middle would be a lasting arrangement. Let but the bill pass, and within six months after the railway was open an interesting collection of broken cables would be on exhibition in the Houses of Parliament. It is amazing that the question of the shifting of the route of the proposed railway a few hundred yards to the east or west of Exhibition Road seems to be altogether neglected.

NOTES.

HONOUR has been done lately to two British men of science by the Academy of Sciences of the Institute of France. On March 6 Sir Joseph Lister was elected a Foreign Associate in succession to the late Sir Richard Owen, and on March 20 Sir Henry Roscoe was elected a Correspondent in the section of chemistry in succession to the late M. Abria.

THE Brazilian expedition, under charge of Mr. A. Taylor, for the observation of the solar eclipse has arrived safely at Ceara.

THE Liverpool Marine Biology Committee have recently appointed Mr. J. Henry Vanstone, from Prof. Howes' Laboratory at the Royal College of Science, South Kensington, as Resident Curator of their Biological Station at Port Erin in the Isle of Man. The important addition which has been made to the station during the winter, viz. a two-storied tank and aquarium house, is now finished, and will be open for use at Easter, when Prof. Brady, Mr. Thompson, Prof. Herdman, and several other biologists are going to Port Erin to work. Nine investigators and students have already applied for accommodation at the station during April, and others are coming at later periods during the summer, so there seems every prospect of the institution being well used this season.

IN connection with the conversazione to be held at the Royal College of Surgeons of England on July 5, to celebrate the jubilee of the Fellowship of the College, it has been decided, as this year is also the centenary of the death of John Hunter, to organise an exhibition of pictures, MSS., books, furniture, &c., connected with the great surgeon. In addition to the articles which are the property of the College of Surgeons, the exhibition will include other relics, the loan of which has been kindly promised by the present possessors. The librarian of the College will be pleased to give further information to any owner of Hunterian relics who may be willing to lend them for exhibition.

A VERY successful conversazione was held by the students of the Royal College of Science in the South Kensington Museum on Thursday, March 23. Mr. C. V. Boys concluded the various entertainments by exhibiting Mr. Henry Dixon's photographs of spiders walking on water, Lord Rayleigh's and his own photographs of bursting bubbles, and by showing his interesting experiments with soap bubbles.

THE council of the City and Guilds Institute for the Advancement of Technical Education have nominated the following as members of the Technical Educational Board of the London County Council, viz.:—Mr. Herbert Saunders, Q.C., Sir Owen Roberts, and Dr. W. J. Russell, F.R.S.

THE Camera Club announces that the seventh annual Photographic Conference will be held in the theatre of the Society of Arts on Wednesday and Thursday, April 12 and 13, under the presidency of Captain W. de W. Abney, F.R.S. Papers will be read by some of the leading students of photography, and all photographers are invited to take part in the conference.

SOME time ago the Egyptian Government appointed a commission to examine the building in which the archæological collection is housed at Ghizeh. This commission has now finished its investigations, and, according to the Cairo correspondent of the *Times*, its report shows the condition of the building to be even more dangerous than it was known to be. A fire would completely destroy the building in the course of a few hours. The Egyptian Government propose to have the Museum made fireproof at a probable cost of £90,000, but the result is not expected to be satisfactory. A new building on a

more accessible site would be very much better, but unfortunately the Egyptian Prime Minister declines to sanction the necessary expenditure, which would be about £130,000. He seems to have a very inadequate conception of the extraordinary interest and importance of this famous collection.

THE Göttingen Society of Sciences has recently proposed the following prize-subjects:—For 1893: From Röntgen and Kundt's researches on changes in the optical properties of quartz in an electrical field, there seems to be a close relation between the electro-optic phenomena and elastic deformations of that substance by electrostatic force. An extension of this inquiry to a large number of piezo-electric crystals of various properties of symmetry seems desirable; and attention should be given to whether the phenomena are due exclusively to the deformations occurring in the electric field, or also to a direct action of electrostatic forces on light motion. For 1894: Between the state of a hard elastic body and that of a liquid are a series of intermediate states, producible by mixture. The properties of these need elucidation by experiment; and especially it should be investigated how in the case of viscous bodies the laws of those movements vary, which, in the case of liquids of small viscosity, can be used to determine internal friction. Papers to be sent in with motto, &c., before the end of September in each year. The prize in either case is about £25.

THE following are the arrangements for lectures at the Royal Victoria Hall during April:—April 11, Principal Garnett, "Some Pioneers of Electricity," with experiments; April 18, Prof. A. C. Haddon, "The Life of a Papuan Savage," with lantern illustrations taken by the lecturer in New Guinea; April 25, Prof. Hudson Beare, "The Printing Press" with special reference to newspaper work.

MR. G. P. BAILEY writes to us that the meteor seen on Saturday, March 18, by the Dundee correspondent whose communication we printed last week was observed also at Kingsland, Hereford. Mr. Bailey was informed of it by the observer on the following day. From what Mr. Bailey can gather, the meteor appeared about 6.20 in a north-north-easterly direction. When first seen it was evidently nearing the end of its flight, and after moving towards the north-west for about three seconds it was hidden by an intervening hill. The trail left behind was visible for about twenty minutes. When first seen the altitude would be about 30°.

THE weather during the past week has been exceptionally fine in the British Islands, owing to anti-cyclonic conditions, which extended over the whole of western Europe. During the first part, the day temperatures were much above the average, generally exceeding 60°, and even reaching 69° in the Midland and eastern counties, while the nights have been very cold, with sharp frosts on the ground, and fog was prevalent in many parts in the early morning. The range of temperature has consequently been very large, exceeding 40° in the twenty-four hours on one occasion. On Sunday both solar and lunar haloes were visible at many stations in the south, and the anti-cyclone partially disappeared from western Europe; but these indications of disturbed conditions were only of a temporary character, although the barometer began to fall irregularly. The day temperatures became several degrees colder, owing to the persistence of easterly winds, but the readings were still high for the season. A special characteristic of the week has been the dryness of the atmosphere, scarcely any rain having fallen in any part of the British Islands, with the exception of a quarter of an inch measured at Valencia Observatory on the 25th instant. The *Weekly Weather Report* shows that for the first quarter of the present year there is a deficiency of rainfall in all districts, amounting to nearly four inches in the west of Scotland. The percentage of possible sunshine for the week ended the 25th instant was higher in nearly all districts than any obtained in the month of March since sunshine recorders were established, in 1881. The duration ranged from 36 to 66 per cent. in Scotland, 52 to 60 in Ireland, and 62 to 82 in England, while in the Channel Islands the percentage was 91°, being a higher weekly value than hitherto recorded at any time of year.

THE Deutsche Seewarte has recently published part v. of the observations made under its auspices beyond the sea. The stations now number sixteen, of which six are in Labrador, five in Africa, one in each of the following places:—Korea, Apia (Samoa), Brazil, Arabia, and Persia. Four of the stations included in this part are new, viz. Tripoli, Baliburg (West Africa), Apia, and Campinas (São Paulo). The observations are taken thrice daily, with good instruments, and all needful particulars are given about the stations, so that the series forms a very valuable contribution to our knowledge of the meteorology of remote regions.

WE have received from Mr. S. B. J. Skertchly an account of a remarkable cold wave which passed over the southern part of China in January last. Since the establishment of the Hongkong observatory in 1884 the lowest temperature observed in any previous month was 40°·3, and this did not last more than an hour, but from January 15 to 18 inclusive the thermometer did not rise above 46°, and fell as low as 32° at the sea level on the 18th. Simultaneous observations collected for 4h. p.m. from other localities show that the cold wave travelled a considerable distance from the north to the south of Hongkong. The readings were:—Canton 37°, Hongkong 35°, Macao 36° on the 16th, and Haiphong 46° on the 17th. The comparative severity of the cold is also shown by the following values deduced from Hongkong observations for January 1884-8:—Mean minimum 56°·1, absolute minimum 41°·8. Dr. Doberck reported that neither snow nor hail was seen in Hongkong, but the hills appeared to be covered with snow or hoarfrost, and a few hundred feet above the sea level both the grass and branches of the trees were covered in unusually clear and transparent ice, without any appearance of crystallisation. The Chinese, who had never seen such a sight, brought down a quantity and sold it as medicine. At Macao, however, a quantity of soft hail fell and lay from 3 to 6 inches in depth where the wind had drifted it. The effect upon vegetation a few hundred feet above the sea was disastrous; nearly all the trees seemed burnt up, and nearly the whole of the butterflies on the wing were killed. This was the coldest spell known to have occurred in China for over fifty years, and it was apparently due to a tongue of cold air being pushed below the warmer stratum. The atmospheric circulation at the time was anticyclonic, and snowstorms were reported from the northward and eastward of Hongkong.

THE Central Physical Observatory of St. Petersburg has commenced from January last the issue of a monthly meteorological bulletin referring to European Russia. It contains four pages of tabular matter, one of which includes the observations taken at 73 telegraphic reporting stations, and the other three contain rainfall observations taken at 312 stations, all the monthly means being calculated according to the Gregorian calendar. The tables are followed by a general discussion of the weather of the month, and of the various meteorological elements, and, lastly, a map is given showing the mean monthly isobars, isotherms, and distribution of rainfall. With the exception of the preface, which Dr. Wild has translated into German on a fly-leaf, the whole of the work is written in Russian, which, although one of the most methodical of modern languages, is not yet generally read in Western Europe, so that the usefulness

of this valuable publication is more restricted than it otherwise would have been.

AN instructive record of medical experience at Davos Platz is given by Dr. Spengler in *Fortschritte der Krankenpflege.* It relates to the two and a half years from November 1887 to May 1890. Communication is kept up with patients after leaving, and the statistics give, in 177 cases, 28·8 per cent. (51 cases) as "cured," 14·0 per cent. as "perfectly fit for work," 17·0 as "still ill," and 31·6 as dead. (In 17 cases, or 9·6 per cent., there is no record.) Thus, a permanent cure seems to have been effected in 42·8 per cent. of the cases. It is noted that most of the patients were subject to influenza in the epidemic of 1889–90. Dr. Spengler gives details of the treatment followed at Davos. We note that, at the outset, till acclimatisation is completed, and the patient has slept well one or two weeks, he lies much in the open air, and takes little exercise. Patients who come with fever soon lose it, and for this reason Dr. Spengler has found Koch's much denounced tuberculin advantageous in certain cases, and still makes use of it. The local or valley wind at Davos is always from the north-east, so that patients can enjoy the sun on the south side of the houses; and in this Davos has an advantage over the Engadine valley (also lying north-east to south-west), where the valley wind is from the south-west.

PROF. ELIHU THOMSON in the *Electrician* gives an account of a curious case of the apparent attraction of closed circuits by an alternating magnetic pole. He finds that when a disc of copper is brought near the pole of an electro-magnet traversed by an alternating current it is at first repelled, but that if its diameter is less than that of the core of the magnet, the repulsion diminishes as it gets nearer and at last becomes an attraction. The explanation given is that the currents induced in the disc, on account of its small diameter, do not suffer as great a lag as when induced in rings or discs which surround the pole; hence the repulsion is feeble, so that it is at last overpowered by the attraction between the induced currents and the iron of the core.

AT a recent meeting of the Société Française de Physique M. d'Arsonval gave an account of his experiments on the physiological effects of electric currents of high frequency. The currents used ranged from one-half to two amperes and were obtained as follows. The internal coatings of two small Leyden jars were connected to the terminals of a large Rhumkorff coil, while the internal coatings were connected through a spiral of from fifteen to twenty turns of thick copper wire. When a spark passes between the terminal knobs of the coil, oscillations are set up, and on account of the self-induction of the spiral of wire if the person or tissue to be experimented on is connected to the two ends of this spiral it will be traversed by a current of very high frequency. The following results were obtained:—(1) The currents are not felt although they are of sufficient strength to light up a lamp requiring two amperes, when held between two persons who complete the circuit. (2) The power of feeling the effects of currents of low frequency is diminished in all parts of the body traversed by these high frequency currents. (3) Zones are formed round the electrodes (which consist of wet sponges) in which all sensitiveness to pain is for the time being lost. (4) A remarkable effect is observed on the nerves which regulate the size of the blood-vessels (vaso-motor nerves), for the vessels dilate to such an extent that in some cases, when an animal was subjected to the current, the arterial pressure fell more than a quarter of its normal value. M. d'Arsonval maintains that these observations show that the reason these currents are not felt cannot be owing to their being confined entirely to the skin. He also suggests as the true explanation that the frequency is so high that the sensory nerves are not affected, just as the auditory and visual nerves are not sensitive to vibrations of certain frequencies.

THE Royal Commission appointed to investigate the condition and education of the blind, the deaf and dumb, &c., did everything in its power to secure the best evidence that could be obtained. Among those who brought forward facts as to the deaf were the well-known American authorities, Dr. E. M. Gallaudet and Dr. A. G. Bell. Last year their evidence was printed in America, with some other matters, in a separate volume, and an elaborate index was prepared by Dr. J. C. Gordon. This index has been carefully revised, and has now been issued by the Volta Bureau, Washington, the compiler having added to its value by the preparation of various "notes and observations." The volume may be of considerable service to serious students of the subject.

THE *Board of Trade Journal* gives an account of a very interesting report prepared by M. P. Mouillefert, Professor at the National School, Grignons, on the vineyards of Cyprus. He thinks that by its situation, its broken surface, its general incline, rising from sea-level to an altitude of over 6000 feet, Cyprus offers the most varied and favourable conditions for the cultivation of the vine. This cultivation is, even at the present day, of real importance, not only from its area, which covers almost 145,090 deunums (100 deunums = 2·47 acres), but from the value of the produce it yields, which exceeds 3,500,000 francs, and affords a livelihood to over 10,000 families. The method of cultivation, however, and the manufacture of the wine fall far short of what they should be, and this is owing to the ignorance and the poverty of the people. M. Mouillefert gives elaborate instructions as to the changes of method which he considers necessary, and expresses his belief that if they were adopted Cyprus might become "the vineyard of Great Britain." One of his proposals is that a professor of agriculture should be appointed who would confer with the villagers and gradually induce them to adopt the proper system of vine cultivation. Meetings and exhibitions, at which prizes were given, would also, he thinks, be an excellent way of encouraging the producer to improve his method of cultivation and his produce.

IN the current number of the *Mediterranean Naturalist* it is noted that upwards of 60 per cent. of the earthquakes that have been recorded have occurred during the six colder months of the year—the maximum number in January and the minimum number in July. These are the results of calculations for the whole area of the globe. The calculations made for separate earthquake districts are said to be in full accord with them, and to show in some cases even a greater proportion for the cold than for the warm season. This is especially the case in the Mediterranean area, where the number of shocks experienced during December, January, and February are to the number felt during June, July, and August as 5 to 2.

THE Technical Instruction Committee of the Essex County Council has published what it calls a "Report and Handbook." The volume contains a most creditable record of work done during 1892, and ought to be of no small service to similar committees in other parts of the United Kingdom.

MESSRS. GAUTHIER-VILLARS have issued the fifteenth report of the International Committee of Weights and Measures. The report relates to the work done in 1891.

THE fifth volume of the "Œuvres Complètes de Christian Huygens" has just been published. It consists of correspondence carried on in 1664–65. This magnificent edition, to which we have repeatedly called attention, is being issued by the Société Hollandaise des Sciences.

MESSRS. J. B. BAILLIÈRE ET FILS, Paris, have issued the first volume of a work entitled "Éléménts de Paléontologie," by Félix Bernard. No fewer than 266 figures appear in the text. The same publishers have issued in their "Bibliothèque Scientifique Contemporaine" a book on "Les Lichens," by A. Acloque. He deals with the anatomy, physiology, and morphology of the lichenic organism.

MESSRS. GEORGE BELL AND SONS have issued the second volume of Mr. George Massee's "British Fungus-Flora," a classified text-book of mycology. The work will be completed in three volumes.

PROF. B. KOTÔ has contributed to the Journal of the College of Science, Imperial University, Japan (vol. v. part 3) a learned paper on the Archæan formation of the Abukuma Plateau. The paper is illustrated with several plates.

MESSRS. BAILLIÈRE, TINDALL, AND COX have published a second edition of Veterinary Captain F. Smith's "Manual of Veterinary Hygiene." The only important alterations in the book are those in the chapter on ventilation.

A VALUABLE "Catalogue of American Localities of Minerals," by Prof. E. S. Dana, has been reprinted by Messrs. John Wiley and Sons from the sixth edition of Dana's "System of Mineralogy."

THE Wagner Free Institute of Science proposes to issue a reprint of T. A. Conrad's monograph of "The Medial Tertiary Fossils of the United States," if subscriptions for 150 copies can be obtained. The original plates would be reproduced by a process of photo-engraving, and a brief introductory chapter and a table would show the present state of the nomenclature of the species contained in the work.

STARTING with an observation by Herz, that the cathode rays causing phosphorescence can pass through thin metallic plates, Herr Lenard has recently made some interesting experiments (described to the Berlin Academy) with an arrangement in which the rays from a small aluminium disc (as cathode) were projected on a thin aluminium "window" (0·003 mm. thick), in a thicker metal plate at the opposite end of the tube. The lateral anode was connected to earth, and a large inductorium was discharged through the tube. These cathode rays passed through the window, and made the air faintly luminous, with bluish light, brightest at the surface of the window. There was a strong smell of ozone. Phosphorescent bodies, bodies brought near the window, glowed, having the same colour as *in vacuo.* At about 2·4 inches distance the phenomenon ceased; it also ceased when the cathode rays were deflected with a magnet, or when a screen of sufficient thickness was interposed. But owing to diffuse spread of the rays the phosphorescent action extended into the shadow of the opaque screen. This field of observation beyond the window could be enclosed and evacuated, and the higher the vacuum, the greater was the distance at which phosphorescence took place, and the sharper and brighter were the rays—indicating (in the author's opinion) that these cathode-rays are a process in the ether. Herr Lenard tried other gases besides air, and found varying penetration by the rays. When coal gas was let pass between the window and the phosphorescent body the latter brightened. When the field of observation (enclosed) was filled with hydrogen at atmospheric pressure, the phosphorescence extended thrice as far as in air at the same pressure (viz. to about 8 inches). Oxygen and carbonic acid were less penetrable than air. "One may say that hydrogen molecules cause less turbidity in the ether than those of oxygen, and the latter less than those of carbonic acid."

NOTES from the Marine Biological Station, Plymouth:—Last week's captures include the Nemertine *Lineus marinus* (=*longissimus*) and the long-spined sea-urchin (*Echinus acutus*). In the floating fauna the principal change has consisted in a great reduction in the numbers of Echinoderm larvæ and in the gradual disappearance of *Aurelia*-ephyræ, as well as in the appearance of numbers of *Arachnactis* (larva of the Actinian *Cereanthus*), of the Leptomedusa *Irene pellucida* (Claus, *non* Haeckel), and of a few *Porcellana* larvæ. In addition to these, small *Obelia* medusæ and the Appendicularian *Oikopleura dioica* have been abundant, and young Ctenophores and Planarians have been occasionally present. The Hydroid *Eudendrium ramosum*, the Nemertine *Amphiporus pulcher*, and the crab *Portunus arcuatus* are now breeding.

THE additions to the Zoological Society's Gardens during the past week include a Mozambique Monkey (*Cercopithecus pygerythus*, ♀) from Zanzibar, presented by Mr. C. E. Reynolds; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. J. W. Jones; a Coypu (*Myopotamus coypus*) from South America, presented by Mr. Arthur Hunt; a double-banded Sand Grouse (*Pterocles bicinctus*) from Senegal, presented by Mr. H. H. Sharland, F.Z.S.; three Common Peafowls (*Pavo cristatus*, ♂ ♂ ♀) from India, presented by Mr. W. Murphy Grimshawe; ten —— Fishes (*Giradinus guppyi*) from Trinidad, presented by the Marquis of Hamilton; a Hawfinch (*Coccothraustes vulgaris*), four Bramblings (*Fringilla montifringilla*) British, purchased; a Hog Deer (*Cervus porcinus*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET HOLMES (1892 III.).—Prof. Keeler, in speaking of the hypothesis that this comet has been produced by a collision between two asteroids, says that the character of the spectrum has little to support this view. He accounts for the brightening on January 16 by supposing that an increase in the number of reflecting particles in the space surrounding the comet took place, *i.e.* by an increase of density, which might result from a contraction following the previously observed expansion of the comet, or, which is more in accordance with the observations, from fresh emanations from the nucleus (*Astronomy and Astrophysics* for March).

Apropos of the same hypothesis, Prof. C. A. Young queries whether, if the asteroids were formed by a series of "explosions," breaking up first the original planet and afterwards the pieces from it, this might not be an event of that sort—an eruption from an asteroid. We continue the ephemeris for the week:—

12h. Paris Mean Time.

1893.		R.A. (app.) h. m. s.		Decl. (app.) ° ′ ″
March 30	...	3 20 48·7	...	+36 7 2
31	...	22 38·7	...	9 44
April 1	...	24 28·9	...	12 25
2	...	26 19·2	...	15 5
3	...	28 9·7	...	17 44
4	...	30 0·3	...	20 22
5	...	31 51·1	...	22 58
6	...	3 33 42·0	...	36 25 33

WOLSINGHAM OBSERVATORY, Circular No. 34.—The star Es-Birm 180 6h. 15·5m. + 47° 43′ was found to be 10·5 March 20 and is variable. On March 18, a red III. Type star, 8·5 mag. was seen at 3h. 23·5m. + 58° 11′ and may be variable. Not in D.M. Places for 1900.

JUPITER AND HIS SATELLITES.—Writing from Arequipa, Peru, Prof. Pickering communicates to *Astronomy and Astrophysics* for March an account of the very valuable and important observations that he made during the past favourable opposition of the planet Jupiter. A minute study of the planet's surface gave him the impression that his surface consists of a "uniform white mass of cloud," over which is stretched a gauzy and thin veil "of a brown material, resembling in struc-

ture our cirrus clouds. Where this veil occurs in denser masses there are the belts, and the phenomena of white spots is nothing less than holes in this veil itself exposing the uniform white layer below. During this period of observation the great red spot was extremely faint and seemed to belong to the white portion beneath, being apparently seen through a hole in the gauzy structure. Since October 8 last, when Prof. Pickering commenced a series of measures with the 13-inch telescope of the diameters of the satellites, some most interesting results have been forthcoming. It was on that day also that he observed one of these small bodies first as an elliptical figure, and then afterwards as a circular one, and later he had the good fortune to watch and observe the disc as it gradually began to assume the elliptical form. After this observation it was found that the other three satellites had at some time been reported as representing an elliptical disc, the shortening taking place equatorially, thus they would seem to revolve about their minor axes. To make quite sure that this was the case and not the result of some optical delusion, Prof. Pickering seems to have instituted various experiments, but the elongations, as he says, "nevertheless remained persistent in the same direction." The first satellite then is a prolate ellipsoid revolving about one of its minor axes in a period of 13h. 3m., while the other three assume at regular intervals the form of ellipses, these periodic changes being produced by the rotation upon their axes.

With respect to the second satellite, the shape of which, by the way, is put down as that of an ellipsoid of three unequal axes revolving about the middle one, and whose period of rotation is 41h. 24m., a curious observation was made in December last. Just about the time of occultation, the equatorial diameter being "decidedly shortened," the satellite retained its shape until almost in contact with the limb, when suddenly "the major axis of its ellipse changed its position angle through thirty degrees, becoming parallel to the limb of the planet." With regard to the other two satellites Prof. Pickering mentions many new facts relating to colour, size, rotation, &c., too numerous to refer to here, but we may say that he has been led to the conclusion that all the four satellites are nothing more than condensed swarms of metorites, like Saturn's ring. In the case of each satellite he gives an ephemeris which indicates the time at which each presents its maximum elliptical phase.

THE HORIZONTAL PENDULUM.—In a volume of 216 pages entitled "Das Horizontal Pendel und seine Anwendung zur Beobachtung der absoluten und relativen Richtungs-Aenderungen der Lothlinie," Dr. E. von Rebeur-Paschwitz brings together all his observations made in the years 1889–92 at the observatories at Wilhelmshaven and Potsdam, and also in Puerto-Orotava on Teneriffe. Besides containing a long discussion on the observations themselves, a very useful collection with short notes of the literature on this subject is added. The pendulum, which was of an isoceles triangle shape, carried a small mirror at the middle part of the shortest side, the movements of which were photographically recorded with the help of sensitised paper and an oil lamp. In addition to numerous seismical appearances, three distinct periodic pulsations were recorded. The first he says is with great probability due to the different positions of the moon, and after supplying the terms containing lunar factors he finds a close agreement between the observed and calculated values—the observations indicating the existence of a tide with a coefficient of 0"·01. With regard to the daily period, he finds that these movements are by no means local, but quite general over the earth's surface; the real cause of these motions do not seem to have been fully brought home, as the magnitudes of the amplitudes seemed to differ considerably locally; but in a note Dr. Paschwitz mentions that the action of the moon on the daily period is in all cases of great importance. The third and last movement, that of the motion of the zero-point, seems to be totally dependent on meteorological conditions.

THE RISING AND SETTINGS OF STARS.—At the present day there are many who are interested in the calculation of star places, times of rising of stars, &c., for times very remote, such as, for instance, in the solution of such problems that have arisen with regard to the orientation of temples, occultations, eclipses, &c. Where we now use the meridian, our early ancestors adopted the horizon, and it was to this plane that they referred many of their astronomical measurements. The heliacal rising and setting, and the cosmical rising and setting are only some of the expressions that were in use to define different relations between heavenly bodies and the horizon at a given time, and only quite recently has the importance of such terms as these been pointed out. In a late publication of the *Astronomischen Gesellschaft*, Bd. xx. Dr. Walter F. Wislicenus has worked out a set of tables for the computation of the yearly risings and settings of stars, and the special problems which can more easily with their help be solved may be stated as: (1) Given ϕ, ϵ, α, δ the latitude, obliquity of ecliptic and coordinates of a certain star for a certain year to find the longitude of the sun at the time of the heliacal rising. (2) Given ϕ, ϵ, for a certain date, and λ for the heliacal rising of an unknown star to find α and δ. (3) Given ϵ, α, δ, for a certain date and also the value of λ at the time of the heliacal rising to find ϕ the place of observation.

GEOGRAPHICAL NOTES.

FRENCH exploration towards Lake Chad is being carried on steadily and successfully. The latest results have been obtained by M. Maistre, who set out from the Mobangi in July, 1892, traversed the south of Bagirmi through the Shari valley, and entered Adamawa by a route never before traversed by Europeans, ultimately descending the Niger, where the expedition reached Akassa on March 25. The health of the expedition was good, and in the earlier part of their work friendly relations were kept up with the natives. In Adamawa, however, there were hostile encounters.

MR. MACKINDER concluded his course of educational lectures for the Royal Geographical Society last week by a masterly discussion of some of the geographical aspects of British history. The effect of the position of the British Isles on their history was summarised concisely in the statement that Britain stands out of the continental world, yet looks into it through its south-east window, and looks not merely into the world, but into the great historic avenue of the world's life. Naturally, therefore, the centre of Britain's national and commercial life has been drawn eccentrically to the south-east corner. This accounts for the inevitable position of London. The configuration of the country, with its natural zones of highlands and lowlands, led with equal clearness to the distribution of peoples and interests, which caused the historic opposition of England and Scotland.

MR. AND MRS. THEODORE BENT, after some delay at Massowa, on account of tribal wars, reached Adowa on the way to Aksum in the middle of February. At Adowa there are Himyaritic ruins of some importance, which Mr. Bent proposes to study before going on to Aksum, where he hopes to have several weeks of active archæological research.

IN a recent report on the triangulation of the north-west portion of South Australia, published by the Government of that colony, the work of the surveyors during the last few years is briefly summarised. From 1888 to 1890 16,000 square miles were surveyed in the form of a belt, about fifty miles wide, stretching from the Anthony Range to the western boundary of the province, a distance of 320 miles. Up to the end of the 1892 season 11,300 square miles of additional land were surveyed. The work in many places was extremely arduous on account of want of water, a supply for the camels having sometimes to be carried for more than forty miles, and for more than a year no rain whatever fell.

THE INSTITUTION OF NAVAL ARCHITECTS.

THE annual spring meeting of this Institution was held last week in the hall of the Society of Arts on Wednesday, Thursday, and Friday, March 22, 23, and 24. There was a fair number of papers on the agenda, of which the following is a list:—

On the present position of the cruiser in warfare, by Rear-Admiral S. Long. Merchant cruisers considered with reference to the policy of maintaining a reserve of vessels by annual subventions to shipowners, by Lord Brassey. Some considerations relating to the strength of bulkheads, by Dr. F. Elgar. On the measurement of wake currents, by George A. Calvert. On the new Afonasieff's formulæ for solving approximately various

problems connected with the propulsion of ships, by Captain E. E. Goulaeff, Imperial Russian Navy. Some experiments on the transmission of heat through tube-plates, by A. J. Durston, Engineer-in-Chief of the Navy. Some notes on the testing of boilers, by J. T. Milton, Chief Engineer Surveyor, Lloyd's Registry of Shipping. On an apparatus for measuring and registering the vibrations of steamers, by Herr E. Otto Schlick. On the repairs of injuries to the hulls of vessels by collisions, stranding, and explosions, by Captain J. Kiddle, R.N. On approximate curves of stability, by W. Hök. Some experiments with the engines of the s.s. *Iveagh*, by John Inglis. On the cyclogram, or clock-face diagram, of the sequence of pressures in multi-cylinder engines, by F. Edwards.

Admiral Long's paper was the first taken, and was a useful contribution to a subject which is more of a military than an engineering or constructive interest. Lord Brassey's paper, on the other hand, is chiefly of interest to the shipowner from a commercial point of view, although a very wide imperial matter is encompassed within the scope of the paper. Lord Brassey maintains that this country cannot maintain her supremacy in first-class ocean liners of high speed, and carrying small quantities of cargo, in face of the foreign competition supported by state subsidies. Our own post-office contribution for carrying mails is insufficient for the purpose of enabling British shipowners to compete with those of foreign states. In the humbler class of ocean cargo steamers we can hold our own, as proved by the figures quoted. The matter is well worthy of the attention of statesmen. Admiral Long's and Lord Brassey's papers were discussed together, and occupied the whole of the Wednesday morning sitting.

On the Thursday, the second day of the meeting, a paper by Dr. Elgar was the first on the list, and is the outcome of some remarks made by the author in a speech during the discussion of Mr. Martell's paper of last year upon a similar subject. Dr. Elgar refers to the report of the Board of Trade Committee upon the spacing and construction of water-tight bulkheads in ships, saying that this report raises broadly and pointedly the question of how the strength of a large area of perfectly flat thin steel plating, which is supported at the edges and subjected to normal pressure, may be determined by calculation. This, the author says, is the simplest form of the question thus raised. In applying it to the case of a ship's bulkhead we require to deal with a continuous area of plating whose thickness is uniform, but with an area made of separate plates of varying thickness, and connected with riveted joints, which has stiffening bars riveted across in parallel lines at equal distances apart. Dr. Elgar pointed out that what is required is further experimental data upon which to base a theory of use to ship-designers in determining these points. In the discussion which followed Dr. W. H. White, the Director of Naval Construction, and assistant controller, supported the author's contention, as also did Mr. Martell, the chief surveyor of Lloyd's, and Mr. Bryan, of Cambridge. The two former, who, it is needless to state, are influential members of council, advocated that a research committee should be formed for the purpose of investigating the matter and accumulating experimental data. Sir Edward Harland, who was chairman of the Board of Trade Committee before referred to, opposed this suggestion on the ground that the Board of Trade Committee had made experiments sufficient for the purpose, and until those experiments had been proved to be defective he thought that any further sums spent would be largely wasted. We do not think the meeting was in accordance with Sir Edward's views. As Dr. White pointed out, the experiments made under the supervision of Sir Edward Harland were more of the nature of experiments on individual girders, rather than on plated surfaces, supported by stiffeners, the stiffeners being treated as the girders. As Mr. Bryan said, what ship-builders really want is a rule based on scientific investigation by which they can be guided in cases where there is not absolute experimental data. We quite agree with Mr. Bryan that this subject wants to be lifted out of the region of empiricism which has always surrounded it. There is, however, not much prospect of the committee of the Institution being formed, not on account of its being unnecessary, but because there are not sufficient funds at the disposal of the Institution. Dr. White was anxious that the members should be asked to express formal approval of the step to be taken in carrying out this investigation, in order to strengthen the hands of the council. We think, however, that no strengthening of this nature is requisite, for, if we mistake not, such work as this is directly within the scope of the Institution, as set forth by the original design upon which it is based.

Lord Brassey, who occupied the chair, advised that the council should memorialise the Board of Trade in order that the Government might take the matter up. No doubt if such a step be taken, a committee will be formed, and those members who have taken a prominent position in the discussion of these matters would no doubt be willing to act—in fact they could not very well refuse. It is to be hoped also that Mr. Bryan, although not a member of the Institution, will be included in the list. It is very desirable that practical consideration should be kept strictly in view in such a matter as this, but in order to be practical, the investigation should be based on a scientific foundation. There are several naval architects who are mathematicians in the best sense of the word. Mr. Bryan is, however, a mathematician first, and that of a very high order, having distinguished himself at Cambridge. His grasp of mechanical subjects has also proved considerable, as evidenced by the original work done at the Cambridge Philosophical and his contributions to the British Association. His paper on the buckling of the thin plate will be remembered in this connection, and since then he has turned his attention to a study of the buckling of plates. His inclusion in the committee would be a guarantee that any experiments made would include the whole subject and not be simply girder tests.

Mr. Calvert has take up a very interesting subject for investigation. The measurement of a steamer's wake is a problem that has been looked on by many as practically insoluble, but Mr. Calvert has attacked it in a practical and philosophical manner. He has towed a large vessel, 260 feet in length, measuring the velocity of the wake by means of towing logs. This vessel was towed from Holyhead to Liverpool. Unfortunately the experiment was not so successful as might have been hoped. The speed of the vessel varied during the voyage and the logs only showed the average. The action of the rudder also affected the stream-lines. There were other sources of error. The author therefore was reduced to model experiments, the vessel he used was $28\frac{1}{2}$ feet long, and 3·66 feet draught. Across the stern was fitted a framework upon which several fine vertical wires were stretched, extending from the deck to some distance below the keel, each of these wires, and the apparatus connected with it, being exactly similar to its neighbours. Upon the wires at the level at which the weight measurement was required a horizontal tube, $\frac{1}{8}$ inch internal diameter, was carried by a universal joint near its forward open end. The end of this tube was in communication with another tube, closed at its upper and lower ends, and hung by trunnions to one end of a weighted lever. One of the trunnions being hollow formed a connection through the rubber tube to the under side of a gauge glass inside the model, so that through this system of jointed tubes there was free communication between the gauge glass and the water outside. On the after end of the tube four thin radial feathers were fixed, and as the weight of that end of the system of tubes was accurately balanced by a lever, the horizontal tube necessarily assumed a position parallel to the direction of any current in which it might be placed, and its open forward end was consequently always presented normally to the current.

In order that the attitude of the submerged tube might be noted by the observers in the boat, the vertical tube carried a light rod, the top of which indicated the inclination in any direction of the tube; four or five of such horizontal tubes were fitted at one time, each on its vertical wire, and having its connections as described, and another such tube with similar connections was carried by an outrigger reaching out into water that was practically undisturbed. Records were taken by means of a photographic camera. If the water into which these horizontal tubes advanced were at rest, or if its velocity throughout were uniform, then the water in the gauge glasses, rising higher and higher as the speed increased, would still stand at the same level in all the glasses. Assuming that the tube carried by the outrigger was always advancing into undisturbed water, then the water in the gauge glass connected with that tube would serve as a datum line from which, at that instant, the relative elevation or depression of the water in any other gauge glass could be measured, indicating to its corresponding horizontal tube that the water through which it was passing was either following or meeting the boat. The wave of the boat was a disturbing element which had to be allowed for. The data being appraised

by means of photographing the waves' profile. The author also towed a flat plank, 28 feet long, at a speed of 406 feet a minute. The speed of current recorded at distances of 1 foot, 7 feet, 14 feet, 21 feet, and 28 feet from the leading end were respectively 16 per cent., 37 per cent., 45 per cent., 48 per cent., and 50 per cent. of the velocity of the plank. These proportions appear to be maintained at all speeds between 200 and 400 feet per minute. Having thus determined the maximum velocity of the frictional water, other experiments were made with this plank to show the manner in which the motion of the water in contact with the surface was gradually imparted to the layers of water lying underneath. This was done by means of tubes, the forward ends of the tubes being open, and their after ends connected to gauge glasses. The results of experiments at 200, 300, and 400 feet per minute would appear to show that the velocity decreases in a geometrical progression as the distance from the surface increases in arithmetical progressions. The retardation of velocity in the somewhat analogous conditions of orbital wave motion of the flow of rivers, and possibly of glaciers, appears to confirm the foregoing observations as regards the ratio of decrease in velocity of the frictional weight. Mr. Calvert next went on to refer to the labours of Dr. Froude, and his report to the British Association for 1874. We regret that space does not allow us to accompany him in this most interesting investigation, and we must refer our readers to the Transactions, in which the whole matter will be published in full. In the discussion which followed, Dr. White, Mr. Froude, and others spoke, but no new facts were brought forward.

The next paper of interest was a contribution by Mr. A. J. Durston, Engineer-in-Chief of the Royal Navy, and dealt with the important matters which are comprised in the problem of leaky tubes. Our readers will be aware of the trouble that has arisen in the Navy from the leakage at tube-plates and tube-ends, where marine boilers have been driven to their maximum. The difficulty has been got over to a certain extent by the introduction of a peculiar form of ferrule. These ferrules are bent over at their ends and protect the joint of the tube and tube-plate from the fierce impact of flame. Naturally the ferrules themselves get burnt away, as there is an air space between them and the heated surface of the boiler by which the heat would be abstracted from the end. With malleable cast-iron, the destruction is not so rapid as one would imagine, for, we believe, although the fact was not stated at the meeting—that a spare set is all that is provided for a commission, that is to say, two sets of ferrules, one in position and one spare will last for three years. The experiments upon which Mr. Durston's paper is founded were made in various ways, with parts of boilers constructed especially for the purpose. The temperatures were generally ascertained by means of plugs at fusible alloys let into the plates through which the heat was transmitted. An interesting series of experiments was also made as to the temperature of the products of combustion at different distances within the tubes of a boiler. This was done by means of a Le Chatelier pyrometer. And it may be said that the curve of temperatures obtained in this way agrees very closely with the curve of evaporation obtained by Mr. Wye Williams. We have not space to give the details of Mr. Durston's many trials. One very striking thing was the extremely deleterious result of grease in the boiler, by preventing the proper transmission of heat.

Mr. Milton's paper followed. Its object was to show that when a cylindrical boiler of the return tube type is subjected to pressure the staying of the combustion chambers to the shell has an effect of distorting the shell, dragging it out of the cylindrical form, thus the flat surfaces of the combustion chambers tend to bulge inwards on themselves, and away from the shell. This sets up strains which are not equally distributed around the whole circumference of the shell. In order to overcome this, Mr. Milton proposes to stay the combustion chambers with stays radiating from the centre of the shell and distributed all round, so that the stress will be equal on all parts. The author quoted experiments showing that the distortion due to the cause named is far greater than is generally supposed by engineers, in one case amounting to as much as one-eighth of an inch on the diameter. This was at a pressure of 320 lbs. on a boiler 14 feet in diameter having three combustion chambers.

Herr Schlick's paper was of remarkable interest. He has devised an instrument by which a record is obtained, not only of the vertical but of the horizontal vibrations of steamers. Without the aid of illustration it would be impossible for us to describe this very ingenious apparatus. Vibration is an important factor in the design of modern steamers of high speed. Our readers will remember Mr. Yarrow's contributions on this subject, and the very valuable practical results he adduced from the experiments made on torpedo boats. In ocean steamers the question of vibration is now one of great moment. In one well-known Atlantic liner the vibration at one time was a serious objection to the vessel, and the nodal points of vibration were well marked in the length of the vessel, so much so that cabins on these points were greatly preferred, and those who were fortunate enough to be in the confidence of the stewards were able to secure these cabins. It has been shown that the action of the screw itself had very little to do with this vibratory disarrangement, it being the synchronisation of the reciprocating parts of the engine with the natural vibration of the structure of the hull that produces the effect in the most aggravated form.

Mr. Hök's paper on curves of stability is a valuable contribution to the Transactions of the Institution. The author is himself engaged practically in work of the nature which he describes, being a draughtsman in a shipyard on the north-east coast. The Institution can hardly have too many papers from authors of Mr. Hök's position and attainments. We do not propose here to enter into a description of the geometrical principles upon which the author bases his formula, and must refer our readers to the Transactions of the Institution for details. The system claims to give no more than approximation, but it is applicable to all kinds of ships and has the great merit of being readily constructed.

The last evening of the meeting Mr. John Inglis gave some interesting particulars of experiments made with a view to test the desirability of running triple compound engines as two cylinder compounds when low power only is required. The system has been frequently advocated with a view to save coal, but Mr. Inglis's results do not seem to bear out this claim. Two four-hours' trials were made, one with the engine working as an ordinary triple, and the other with the intermediate cylinder thrown out of use. Working triple, the I.H.P. was 810; working two cylinders, 351. In the former case the coal consumed per I.H.P. per hour was 147 pounds. With the intermediate cylinder out of use the coal was 2·238. The consumption of feed water corresponding was 15·25 pounds, and 23·18 pounds per I.H.P. per hour. Of course the comparison must not be taken as indicating degree of the superiority of the triple expansion engines over the ordinary compound, great as that superiority undoubtedly is.

A paper by Mr. Cole on the same subject follows, but the results obtained are not sufficiently conclusive to demand quotation.

The last paper at the meeting was the contribution by Mr. Edwards. Its title sufficiently explains its scope, and it would be quite impossible for us to follow the author's explanation without the aid of the diagrams which he exhibited on the walls of the theatre.

The chief event of the meeting was reserved for the last. It was the presentation of an address to Lord Ravensworth, who for fourteen years has occupied the position of president to the Institution. He now retires, his successor being Lord Brassey. The address referred to the great services that Lord Ravensworth had rendered to the Institution, and the authors of it gave utterance to no conventional platitudes. Lord Ravensworth has worked hard for the Institution of Naval Architects, and has conducted its meetings without favour to any, so that the humblest member could get a hearing equally with the most distinguished. It is not always so in societies of this nature.

A summer meeting of the Institution will be held at Cardiff, a very cordial invitation having been received from the Welsh metropolis. The meeting promises to be of unusual success, judging by the programme which is set forth, and the arrangements made.

THE ACTION OF GLACIERS ON THE LAND

PROF. T. G. BONNEY, F.R.S., read a paper to the last meeting of the Royal Geographical Society on the question, Do glaciers excavate? In view of the correspondence recently published in our columns the arguments adduced in support of the negative conclusions may be cited in some detail.

The question of the glacial origin of lakes involves many separate considerations. While lakes undoubtedly abound in regions now or formerly subjected to glaciation, many of these are formed by the damming of valleys by moraine heaps, or by extensive landslips. The school of Sir A. Ramsay affirm that glaciers are powerful excavating agents, and that there is no other agent but ice competent to form a rock-basin. The last argument breaks down when one considers the number of depressions of all sizes gradually increasing from mere volcanic craters to those of the Jordan Valley and the Caspian Sea, in the formation of which ice could have had no part. The argument that Greenland alone holds the key to the phenomena of glaciation breaks down, for the Alps were once the seat of a vast ice-sheet, which over-rode all the minor inequalities of the surrounding country, and of which the existing glaciers are the shrunken remnant. Thus the Alpine valleys should serve to show the typical results of ice-action on the land. This is the sum of their evidence: toothed prominences have been broken or rubbed away, the rough places have been made smooth, the rugged hill has been reduced to rounded slopes of rock (like the backs of plunging dolphins). But the crag remains a crag, the buttress a buttress, and the hill a hill; the valley also does not alter its leading outlines, the V-like section so characteristic of ordinary fluviatile erosion still remains; all that the ice has done has been to act like a gigantic rasp; it has modified, not revolutionised, it has moulded, not regenerated. No sooner do we come to study in detail the effects of the ancient glaciers in the upper valleys of the Alps than we are struck by their apparent inefficiency as erosive agents. Here, where the ice has lingered longest, just beneath the actual glacier we see that a cliff continues to exist. Again and again in a valley we may find that on the lee side of prominences crags still remain, sometimes in sufficient frequency to be marked features in the scenery. The Haslithal is an excellent and representative example. The result of prolonged personal study of the Alps may be summed up in the words—"Valleys appear to be much older than the Ice Age, and to have been but little modified during the period of maximum extension of the glaciers."

The evidence as to the erosive power of glaciers is very slight. Dr. Wright showed that the great Muir Glacier in Alaska covers great stretches of undisturbed gravel in which upright tree-stems remain. Prof. Bonney proceeded to say:—In the Alps about the year 1860 the glaciers began to dwindle. By 1870 considerable tracts of bare rock or debris were exposed, which a dozen years before had been buried under the ice. On none of these have I seen any basin-like hollow or sign of excavation as distinguished from abrasion. The Unter Grindelwald Glacier in the last stage of its descent passes over three or four rocky terraces. The angles of these are not very seriously worn away, nor are hollows excavated at the base of the steps. The bed of the Argentière Glacier (I made my way some little distance under the ice) was rather unequal, and was less uniformly abraded than I had expected. There were no signs whatever of the glacier being able to break off or root up blocks of the subjacent schistose rock: it seemed simply to wear away prominences. This also is true of other glaciers. Prior to 1860, and again in 1891, I saw glaciers which were advancing. They ploughed up the turf of a meadow for a foot or two in depth; they pushed moraine-stuff in front of them, showing some tendency to over-ride it, and nothing more. In 1875, at the foot both of the Glacier des Bois and of the Argentière Glacier, was a stony plain. Both these proved to have been recently uncovered by the ice; in other words, the glacier had not been able to plough up a boulder-bed even at a place where, owing to the change of level, some erosive action not unreasonably might have been expected. But, further, on both these plains big blocks of protogine were lying which were striated on sides and top, thus showing that the ice had actually flowed over them, as if it were a stream of mud. Some of the difficulties in the way of believing in the scooping out of lake-basins have now to be considered.

First, in regard to their position: some of them, such as Constance, Geneva, Como, Maggiore, &c., are comparatively near to the lower limits of the great ice sheets, and so would be covered for a relatively short time. All of them are many miles from the ends of the existing glaciers, yet we are asked to admit that a rock basin, in depth sometimes exceeding 1000 feet and generally more than 500, has been scooped out in a time much shorter than that which has proved insufficient for the obliteration of the original features of the upper valleys or for the deepening of their beds by more than a few yards at most—indeed, as a rule, the ice seems never to have been able to overtake the torrent.

The radiating arms of the Lakes of Lucerne, Lugano, and Como are insuperable difficulties in the way of accepting a glacial theory of the origin of these lakes, and the configuration of the Lake of Geneva and the other lakes in France recently minutely surveyed, lends no countenance to the theory of excavation.

One fact to which Prof. J. Geikie has called attention seems at first sight strongly to support Sir A. Ramsay's hypothesis, and is the only real addition, in my opinion, which has been made to the original reasons. It is that many of the Scottish lochs are true rock basins, and that similar basins frequently occur outside their mouths. This also often holds of the fjords in Norway, New Zealand, and elsewhere. Prof. Geikie points out that several of these basins occur just when the ice might be expected to obtain an increased scooping power. His map at first sight appears very convincing; but a study of the larger charts reveals many anomalies. Loch Linnhe, for example, from below the entry of Loch Leven, maintains a general depth of from 34 to 50 fathoms; then, below Loch Corrie, a channel may be traced which varies in depth from 50 to 60 fathoms, after which, in the Lynn of Morven, we find it deepen to 70 fathoms, then to 90 fathoms; and at last, a little north-east of the line joining Barony Point with Lismore Point, it expands into a basin with a maximum depth of 110 fathoms. But outside, in the Sound of Mull (to the north-west) the depths become very irregular, varying from about 35 to 70 fathoms. Barony Point appears to be connected with Mull by a submerged isthmus, generally less than 20 fathoms below the surface. But here, if the glacier were stopped by impinging on Mull, it ought in splitting to be pushing hard upon its bed. In all this region the irregularities of the bed are very perplexing, whatever hypothesis be adopted; but I will restrict myself to a single instance. Off the west coast of Scarba, under the lee of the "Islands of the Sea," and where the opening towards Colonsay makes it improbable that the ice can have forced into a narrower space, an elongated basin occurs in which the soundings—outside about 60 fathoms—deepen to 100, and at one place to 137 fathoms. The sea-bed about Arran presents similar difficulties. In short, here, at Loch Etive, Loch Lomond, and in other places, all goes well only so long as we restrict ourselves to generalities and abstain from details.

The theory of the origin of rock-basins, which I brought forward full twenty years ago, is now supported by much additional evidence. It is that the lake beds are ordinary valleys of sub-aerial erosion, affected by differential earth-movements. This has been very strongly confirmed by the surveys of the old beaches of the great lakes of North America, the Iroquois beach being full 600 feet higher at the north-eastern part than it is at the western end of Lake Ontario.

To conclude, glaciers, when the paths which they have traversed are carefully studied, appear to have acted, as a rule, as agents of the abrasion rather than of erosion. Even in the former capacity they have generally failed to obliterate the more marked pre-existent features due to ordinary fluviatile and sub-aerial sculpture. In the latter capacity they seem to have been impotent, except under very special circumstances; thus, while we may venture to ascribe to glaciers certain shallow tarns and rock basins in situations exceptionally favourable, we cannot assign to their agency either the greater Alpine lakes or any other important lakes in regions which were overflowed by the ice only during the period when it attained to an abnormal development. In the discussion which followed the paper, Dr. Blanford, Sir Henry Howorth, Mr. Freshfield, and Mr. Conway took part.

FURTHER STUDIES ON HYDRAZINE.

A FURTHER contribution to the chemistry of hydrazine, N_2H_4, is communicated by Prof. Curtius to the current number of the *Berichte*. The first portion of the memoir deals with the preparation and properties of substituted hydrazines containing the radicles of the organic acids. In the latter portion a number of inorganic salts containing hydrazine are described.

When hydrazine hydrate is brought in contact with the amides,

chlorides, or esters of the organic acids, primary acid hydrazines are produced, of the general structure $R.CO.NH.NH_2$, where R represents the hydrocarbon radical contained in the acid Ammonia, hydrochloric acid, or alcohol is simultaneously formed, according as an amide, a chloride, or an ester is employed. The reactions proceed with facility and regularity, frequently in the cold, and afford theoretical yields of the substituted hydrazines. For many reasons, however, the esters are most convenient for the preparation of these acid hydrazines upon a large scale.

The primary acid hydrazines are colourless, non-volatile solids which usually crystallise well. The first member of the series, formyl hydrazine, $H.CO.NH.NH_2$, melts at 54°. They are usually soluble in water and alcohol, but insoluble in ether. Most of them form stable salts with one molecule of hydrochloric acid. The hydrogen of the imido group NH is replaceable by metallic sodium or by the radical acetyl. They possess reducing properties similar to those of phenyl-hydrazine, and they condense readily with aldehydes and ketones to form insoluble tertiary hydrazines. Upon heating, frequently by simply boiling their aqueous solutions, they become converted into secondary symmetrical hydrazines in accordance with the equation: $2R.CO.NH.NH_2 = R.CO.NH.NH.CO.R + N_2H_4$. The liberated hydrazine decomposes into ammonia and free nitrogen.

The secondary symmetrical acid hydrazines are very stable substances, soluble only to a slight extent in water. They are usually colourless, possess high melting points, and behave as acids. By the action of powerful oxidising agents they are converted into substances endowed with brilliant colours, ranging from yellow to bright red, which appear to be of the nature of "azo" compounds.

Of particular interest is the substituted hydrazine obtained by the action of hydrazine hydrate upon urea, the amide of carbonic acid. When urea is boiled with hydrazine hydrate a monohydrazide is first produced, $NH_2.CO.NH.NH_2$. This substance, however, is unstable and passes spontaneously into the secondary symmetrical compound $NH_2.CO.NH.NH.CO.NH_2$ with elimination of hydrazine, N_2H_4. This secondary hydrazide is identical with a compound of the same constitution previously obtained in an entirely different manner by Thiele.

An extremely interesting reaction occurs when the acidyl hydrazines of monobasic acids are treated with nitrous acid. They are directly converted into esters of azoimide, N_3H, in accordance with the following equation:—

$$R.CO.NH.NH_2 + NO.OH = R.CO.N_3 + 2H_2O.$$

During the course of work upon this latter reaction it was observed that the organic azoimides, both those containing acid and those containing hydrocarbon radicles, $R.CO.N_3$ and RN_3, behave in a peculiar manner with water. Thus diazobenzene-imide $C_6H_5.N_3$ resinises with a copious evolution of gas; similarly benzoylazoimide, $C_6H_5.CO.N_3$, when boiled for some time in contact with water evolves large quantities of nitrogen and carbon dioxide, and becomes converted into a magnificently crystallising base of the composition of a symmetrical diamidobenzophenone, $C_6H_4.NH_2.CO.NH_2.C_6H_4$.

The hydrazines of dibasic acids do not yield derivatives of azoimide, but break up with a violent evolution of nitrogen and formation of secondary symmetrical hydrazines. For instance the hydrazine of oxalic acid yields the symmetrical compound

$$\begin{array}{c} CO.NH.NH.CO \\ |\qquad\qquad\quad| \\ CO.NH.NH.CO \end{array}$$

Several of the hydrazines of unsaturated acids behave in a manner peculiar to themselves. Thus the hydrazine derived from fumaric acid, $C_2H_2(CO.NH.NH_2)_2$, yields with nitrous acid an extremely explosive colourless compound, of the nature of a diazofumaramide, $C_2H_2(CO.NH.N_2.OH)_2$.

Prof. Curtius has succeeded in preparing a large number of double salts of metallic sulphates and chlorides with hydrazine sulphate and chloride. The double sulphates are constituted according to the general formula $(N_2H_4)_2H_2SO_4.R''SO_4$, and are distinguished by their difficult solubility and by the absence of water of crystallisation. Salts of the series have been prepared containing as the metal R'' copper, nickel, cobalt, iron, manganese, zinc, and cadmium; magnesium does not appear capable of forming a double sulphate. The blue copper salt is only soluble to the extent of one part in 1150 parts of water at 10°. It dissolves in ammonia with evolution of nitrogen.

The double chlorides are constituted according to the general formula $N_2H_4.HCl.RCl$. They are readily soluble in water, and certain of them may also be recrystallised from alcohol. Some contain water of crystallisation, while others are anhydrous and exhibit sharp melting points.

Hydrazine likewise forms a double phosphate with magnesium, which closely resembles ammonium magnesium phosphate.

Hydrazine appears to be remarkably stable towards nitric acid, but Prof. Curtius has eventually obtained the nitrate, $N_2H_4.HNO_3$, in splendid crystals which melt at 70°. If these crystals are heated suddenly they explode with great violence. The acid salt, $N_2H_4.2HNO_3$, loses nitric acid when its solution is evaporated. It may be remembered that Prof. Curtius observed a similar greater stability of the monacid salt in the case of the chlorides, for upon heating the dihydrochloride, $N_2H_4.2HCl$, to 140°, it was found to be completely converted into the monohydrochloride, $N_2H_4.HCl$.

A. E. TUTTON.

THE INTERNATIONAL CONGRESS OF PREHISTORIC ARCHÆOLOGY AND ANTHROPOLOGY.

IT is probably unique in the history of congresses that a report of the proceedings should be published within a period of three months from the time of the meeting. Such a feat was accomplished by the publication committee of the International Congress of Prehistoric Archæology and Anthropology, the eleventh session of which was held some time ago at Moscow. All the communications are printed in French. The first volume of the Report is divided into five sections; of these the first is devoted to geology and palæontology in their relations to primitive man. In his paper upon the constitution of the quaternary deposits in Russia and their relations to the finds resulting from the activity of prehistoric man, S. Nikitine draws the following conclusions:—The subdivision of the stone age into palæolithic and neolithic epochs should be retained for Russia in Europe, because it coincides with the geological subdivisions pleistocene and recent, which in their turn are based upon palæontological facts. The study of the glacial deposits of Finland and of the western region do not furnish any proof of the existence of two special glacial epochs and of an interglacial epoch; all the facts can be explained by phenomena of the oscillation of a glacier at the time of its gradual but irregular retreat. The time corresponding to the inter-glacial epoch and that of the second glaciation of the Swedes was probably for the greater part of Russia the period of the formation of ancient lacustrine deposits, of the loess and of the upper fluviatile terraces, containing the bones of the mammoth and other extinct mammals. Man lived simultaneously with the mammoth during the second half of the glacial epoch along the limit of glaciation, knowing amongst other things the use of fire, but only making splintered flint implements. As the glacier retreated man advanced towards the north and north-west; he arrived in Finland and in the Baltic region after the close of the glaciation, and after the disappearance of the mammoth; but man then possessed the more advanced culture of the neolithic period, and besides chipped flint implements he knew how to make implements of polished stone, pottery, &c. Russia in Europe does not present any traces of man in the first half of the pleistocene or of still more ancient man.—Prof. W. W. Dokoutchaïev contributes a valuable essay on the Russian steppes, past and present, in which he deals with the last page of Russian geology, and comes to the conclusion that before the glacial period the difference between the relative altitudes of the north-west and of the centre of Russia were much more considerable than at present. The author describes the carving of the steppes and their surface drainage; their soil, and that of the forests; the vegetation, fauna, and climate of the

steppes. As the soil of the forests differs in character from that of the tchernozème the author and M. Gheorgievsky were able to prove the greater extent formerly of the Poltava forests.—The second section deals with prehistoric archæology. In a paper entitled comparison of the primitive industries of France and Asia, G. Chauvet discusses the question "Can one establish general divisions, applicable to both Western Europe and Asia, for prehistoric times and especially for the palæolithic period?" The general progress of the industrial arts has been the same in Asia and in Europe during prehistoric times, but how far these epochs were synchronous is unknown. In order to have terms for comparison it is necessary to have a "fixed base"; such a base is afforded by the glacial phenomena. He concludes by urging that the great engineering works which are now progressing in Asia afford opportunities for obtaining information on these problems which should not be neglected.—Lubor Niederle (of Prague) calls attention to the latest results of prehistoric archæology in Bohemia, and its relations with Eastern Europe, and arrives at the conclusion that the Slavs arrived in Bohemia earlier than is admitted by historians. He believes that the Slavs, like the Germans and Gauls, were originally dolichocephalic, and of a blonde complexion.—The other papers in this section are short, two of them being on nephrite.—The third section is confined to tumuli and encampments (*Kourganes et goroditchtschés*).—A. Spitzine reports on the bone-encampments in the north of Russia.—P. Krotov comes to the following conclusions in his paper on the layers of stone implements in the district of Iaransk, government of Viatka; the stone implements of the district of Iaransk do not belong to the true stone age, but to the epoch of the encampments and other ancient dwellings of the Finns, who made use of implements of stone and bone, along with utensils in iron and bronze. During this period of the life of the Finns, elements of a more advanced civilization penetrated into their country, coming from the centres of civilization of eastern Russia; flint and bone implements being replaced by iron tools.—B. Pérédolsky has a paper on the "jalnik" (necropolis) of Iuriévo, in the district of Borowitchi, government of Novgorod."—The first paper in the Anthropological Section is by Topinard on race in anthropology, in which he asserts, (1) On no part of the surface of the globe can one discover a population entirely free from mixture, and presenting only a single type; (2) that the anthropological materials on which we work, and from which we extract the double notion of the type to begin with, and of its continuity in time, are only peoples; (3) that if the first factor, the type, is accessible with labour, the second, its permanence in time, is only a conjecture which it is impossible to demonstrate; (4) that in consequence the notion of race in the two factors, and especially in the latter, is only a subjective notion, a mental conception, peoples and their historic elements being the only objective realities. Later on he says: "In order to show how in Europe, for example, the question of nationalities is foreign to that of races, or even of the constituent elements of peoples, one need but remember that three or four races (using the word conditionally) only are fundamentally concerned in the formation of the numerous peoples which at the present time are distributed from north to south, and from east to west. The races are the whites, the brachycephals, and the browns. They are found everywhere, with only here and there some secondary additions. Their proportions alone vary. To the north there are more blondes; in the centre, from the Urals to Portugal, the brachycephals dominate; to the south, around the Mediterranean, the browns are in the majority. If two peoples agree in certain characters it does not follow that they have the same nationality. Kollmann, in an illustrated paper on the human races of Europe and the Aryan question, argues that it is necessary to distinguish at least four different types in Europe (the *Dolichocephalic leptoprosopes* and *chamæprosopes* and the *Brachycephalic leptoprosopes* and *chamæprosopes*) which have continued, without any doubt, since the neolithic period; that the intellectual European culture is a common product of these types.—In his paper on the weight of the brain among several peoples of the Caucasus, Dr. N. Giltchenko gives valuable data on fifty-seven subjects. Anoutchine has a paper entitled, "On Ancient, Artificially Deformed Skulls found in Russia."—The last section is devoted to Prehistoric Ethnography. In his contributions to the prehistoric ethnography of Central and North-East Russia, J. Smirnov concludes that the linguistic facts permit the supposition that only a part of the remains of the neolithic period of Central Russia can belong to the Finns. The antiquity of sepultures can be determined, besides other ways, by the animal bones deposited with the dead. The N.-S. position of the skeleton may be regarded in Central Russia as one of the indices of ancient Finnish sepultures. To the category of the monuments of prehistoric epochs belong geographical names. The place-names of northern and central Russia prove that its pre- or proto-historic population has been more homogeneous to the east, in the region of the Permiens and Ougriens, and more mixed to the west.—N. Troïtzky has a very interesting paper on vestiges of paganism in the region situated between the upper courses of the Oka and of the Don. Fire, tree, and stone cults persist, but modified by Christianity.—E. Chantre has a project for reform in the nomenclature of the peoples of Asia"; and A. Ivanovsky, some information upon the questions: (1) of the simultaneous employment of sepulture and incineration; and (2) of the stone statues called "Kamennya baby."—The last is the most important communication, "Which is the most ancient race in Russia?" by Prof. A. Bogdanov, of Moscow. He finds that the most ancient skulls are dolichocephalic. In passing to the more modern tombs since the fifteenth century, we see a diminution of the quantity of dolichocephals and the preponderance of brachycephals. In the ancient tombs of the government of St. Petersburg, as well as in some districts of Novgorod, we meet from the stone age onwards skulls of a type quite distinct from those characteristic of the tumuli (*kourganes*) of Central Russia. From Moscow eastward, and as far as the Urals and Siberia (Tobolsk), we find the tumuli of the brachycephals. In the governments of Moscow, Smolensk, Riasan, and Don, we have only in some localities the series of the dolichocephals, and in others a kind of mixture of characters; in these localities, more than in the others, mixture was possible, since they are found either on the great routes of migrations, or at the limit of the distribution of different races. In the tombs called "Scythian" the majority of the skulls quite resemble the dolichocephalic tumuli-population of Central Russia. One finds only occasionally Mongoloid skulls in the tumuli of Central Russia, and in the tombs of Southern Russia; whilst in the tumuli of Tobolsk, and of the Uralian countries they abound and often predominate. The territory of this dolichocephalic leptoprosopic primitive people is very distinctly limited to the north, east, and south by the tumuli, with a population quite brachycephalic, or presenting this type in preponderance. There is no south-west limit. In Galicia, north and south Germany, and Sweden we meet with the same type in the ancient tombs as in those of Central and Southern Russia. There are true primitive dolichocephalic chamæprosops in Asia among the Mongolians, but not in Europe. Kollmann's European types appear to be the result of mixture with brachycephals, or of what Virchow calls "pathological races." Dolichocephalism is more and more diminishing in Europe. The larger and broader heads of the civilized classes should be attributed to other causes than merely to mixture.

A. C. H.

SCIENTIFIC SERIALS.

The Quarterly Journal of Microscopical Science for January, 1893, contains:—On the relationships and *rôle* of the Archoplasm during mitosis in the larval salamander, by John E. S. Moore (plate xxi.).—On the occurrence of embryonic fission in cyclostomatous polyzoa, by Sidney F. Harmer (plates xxii.–xxiv.). The extraordinary phenomena described in detail in this paper were announced in brief to the Cambridge Philosophical Society a couple of years ago. The completed investigations of the author indicate in the clearest way that the young larvæ of *Crisia ramosa* are produced as buds from an embryonic mass of cells found in the young ovicell. "At the end of segmentation the embryo consists of a small mass of undifferentiated cells, lying near the distal end of the follicle, which has increased largely in size, and now forms a spherical knob projecting freely into the interior of a spacious tentacle sheath;" after a time "the embryo, although remaining a solid mass

without differentiation of organs, grows out into several finger-shaped processes, which are generally directed towards the distal end of the ovicell" . . . "these finger-shaped processes are divided up by a series of transverse constrictions into rounded masses of cells, each of which becomes a complete larva;" the few rare cases in the Tunicates and Cœlenterata, where the asexual reproduction of buds takes place from very feebly developed embryo forms are cited.—On two new genera and some new species of earthworms, by Frank E. Beddard, F.R.S. (plates xxv. and xxvi.). Describes *Trichochæta hesperidum*, nov. gen. et spec. from Jamaica; *Alvania millsoni*, nov. gen. et spec. from Lagos; *Polytoreutus magilensis*, n. sp. from Magila, East Central Africa; and *Pygmæodrilus lacuum*, n. sp. from Lagos. There are also notes on *Siphonogaster millsoni*, F.E.B.—Observations on the gregarines of Holothurians, by E. A. Minchin, B.A. (plates xxvii. and xxviii.). These gregarines apparently first indicated by Kölliker, and identified by Schneider (1858), have since been studied by Cuénot, Mingazzini, Ludwig and Léger, and have now been closely investigated from fresh material found at Naples and Plymouth, by the author. *Gregarina irregularis*, n. sp. found on the blood vessels of Holothuria, at Plymouth, is described; numerous details about the spores and sporozoites are given, and the difficult question of the affinities of these forms is discussed.—A new Sporozoon in Amphioxus, by E C. Pollard (plate xxix.). These minute parasites were discovered in the epithelium of the intestine. Miss Pollard also figures a ciliate Protozoan found in the atrium of Amphioxus, which had been found some time back by Prof. Ray Lankester, he suggests that possibly the Sporozoon may be a stage in the life history of the ciliate form.—Studies on the Protochordata, by Arthur Willey. I. On the origin of the branchial stigmata, præoral lobe, endostyle, atrial cavities, &c., in *Ciona intestinalis*, Linn., with remarks on *Clavelina lepadiformis* (plates xxx. and xxxi.). As the result of prolonged and very complete investigations, the author finds himself compelled to completely alter his previously published views as to the homologies existing between the various organs of the Ascidians and Amphioxus.

Wiedemann's Annalen der Physik und Chemie, No. 3, 1893.—Electromagnetic theory of colour dispersion, by H. von Helmholtz. A mathematical deduction of Fresnel's and Cauchy's formulæ from the electromagnetic theory of light by means of an application of the principle of least action to electrodynamics.—Magnetisation of a radially slit iron ring, by Heinrich Lehmann. The method employed was practically that of Ewing, with ballistic measurement. The normal curve for the closed ring was first determined. The ring was then slit radially, and the width of the slit regulated by plane parallel discs of brass introduced between the faces, the ring being tightened by a brass collar whenever necessary. To measure the flow of induction through the slit, the brass disc was wound with a number of turns of very fine copper wire. The width of the slit was varied from 0·4 mm. to 3·57 mm., and the strength of the magnetic field from 1 to about 300. It was found that the coefficient of dispersion, *i.e.* the ratio of the mean induction to that at the slit, increased with the width of the slit and finally decreased with increasing field intensity. The divergence of lines of force was practically limited to the neighbourhood of the slit. For each width of slit the coefficient of demagnetisation was constant up to about half saturation point. A formula is given for calculating this coefficient from the geometrical dimensions of the system.—On the influence of temperature upon circular ferro-magnetic polarisation, by Emil Hirsch. Transparent plates of iron, nickel and cobalt were prepared by electro deposition upon a transparent film of platinum burnt into a glass plate 2 mm. thick and free from double refraction. Lippich's half-shadow polarimeter was used for measuring the circular polarisation. The light was furnished by a zirkonium burner, and the magnetic field by a large electromagnet fed with a current of 33 amperes giving a field of 9000 C.G.S. units. The metallic films were enclosed in a brass box heated by two Bunsens, the temperatures being measured by thermometers and an iron-german-silver-thermopile. As a result, Kundt's constant, or the ratio of the rotation of the plane of polarisation to the increase of "magnetisation potential" from one side of the film to the other, was found to be independent of the temperature within the limits of observational error.—Also papers by E. Lommel, F. Richarz, K. Ångström, H. Ruoss, P. Drude, and H. E. J. G. du Bois.

Bulletin de l'Académie Royale de Belgique, No. 2, 1893.—We notice the following papers:—On a new form of blende, by G. Cesáro. The specimen occurred in the granular dolomite of Binnen, in the form of a light yellow translucent crystal 3 mm. in diameter. Its crystalline form is that of the tetrahexahedron, the trihedral angles being truncated by striated scalene triangles.—A new electrical process permitting the production of temperatures superior to those actually realisable, by Eug. Lagrange and P. Hoho. The new method consists in the passage of a current through a conducting liquid by means of electrodes, one of which is made of the substance to be raised by a high temperature. M. Violle has recently estimated the temperature of the electric arc at 3500° C. and found that it is constant, so that it represents the highest temperature attainable by that method. In the new method the heat is developed at the surface of the electrode. During the passage of a current of, say, 2000 volts and 150 amperes through a 10 per cent. solution of sulphuric acid, a layer of gas is formed round an electrode consisting of a plate of graphite, and since the resistance of the circuit is concentrated in this layer of gas, practically the whole energy of the current is transformed into heat in the immediate vicinity of the substance to be operated upon. The temperature rises until the amount of heat, dissipated by conduction and radiation, is equal to that produced. If the production of heat is very rapid, this limit will be very high, and the temperature obtainable depends simply upon the strength of the available current.

Annalen des K. K. Naturhistorischen Hofmuseums. Bd. vii. (Wien, 1892).—The last two parts (Nos. 3 and 4) of the seventh volume of the Annals of the Royal Natural History Museum of Vienna fully maintain the credit of this publication.—In his Contributions to the knowledge of the Crustacea of the Canary Islands, K. Koelbel describes and figures *Livoneca sulcata*, n.sp. and *Munidopsis polymorpha*, n.sp.—The species of *Alectoria* and their geographical distribution, by Dr. E. Stizenberger.—A contribution to the morphology of Corundum, by Dr. H. Barvír. Two twin sapphires are described and figured.—In Part II. of his "Meteoric Studies" E. Cohen gives analyses of twelve American meteorites.—Two plates illustrate F. Siebenrock's paper on the skulls of the Scincoidæ, Anguidæ, and Gerrhosauridæ, twenty-six species of the first and three each of the second and last are referred to.—New forms of Hymenoptera, by F. F. Kohl (three plates), thirty-eight new species are described and one new genus *Heliocausus*.—On the typical specimens of *Lacerta mosorensis*, Kolomb. (1886) (= *Lacerta koritana*, Tom. 1889) by Dr. F. Steindachner (pl. xvi.).—Contributions to the Microlepidopteran fauna of the Canary Archipelago, by Dr. H. Rebel (pl. xvii.). Ten new species and two varieties are described and figured, and one new genus, *Hypotomorpha*. The paper concludes with a valuable index and table of the geographical distribution of sixty-three Microlepidoptera; the distribution includes west and east Canary Islands, Azores and Madeira, N.W. Africa, Mediterranean region, and other regions.—Part IV. contains the following papers:—Remarks upon the species of the genus Potamogeton in the Herbarium of the Royal Natural History Museum, by A. Bennett; three new species are described.—Compositæ Hildebrandtianæ et Humblotianæ in Madagascaria et insulas Comoras collectæ, by Dr. F. W. Klatt (six new species).—Lichenes exotici Herbarii Vindobonensis, by Dr. J. Müller.—The birds of Austro-Hungary and of the land of occupation in the Royal Natural History Museum of Vienna, by Dr. L. R. L. v. Liburnau.—On vertebral assimilation among the Lizards, by F. Siebenrock. Normally but two sacral vertebræ support the pelvis in lizards, but in 1864 Hyrtl described under the term "Wirbelassimilation" deviations from this rule. In this paper several examples are given in which the last lumbar or the first caudal vertebra is connected with the pelvis; a figure is given of the latter arrangement in a specimen of *Uromastix spinipes*, and of the former in a specimen of *Lacerta Simonyi*. The last paper—Old Mexican relics from the Castle Ambras in the Tyrol, by F. Heger—is of ethnological interest. Four photographic plates, and one in colours, illustrate this paper, and, like the majority of the illustrations of this journal, are of the highest excellence.

SOCIETIES AND ACADEMIES.

LONDON.

Mathematical Society, March 9.—Mr. A. B. Basset, F.R.S., Vice-President, in the chair.—Mr. T. J. Dewar exhibited, with the aid of a stereoscope, twenty stereographs of the regular solids. These were not photographs of a solid object from two points of view for binocular vision, but the same object was drawn twice over by Mr. Dewar in perspective with different station points. The relief was aided by making the lines in the foreground thick, and those behind thin.—Mr. Love read a note on the stability of a thin rod loaded vertically. Suppose a thin rod or column is held vertically at its lower extremity, and loaded at its upper extremity. It is well known that, unless the load exceeds a certain limit, the rod will be simply compressed longitudinally without being bent. If, however, the limit is exceeded there exists a curved form in which the rod can be held by the application of the given load. This form must belong to the *elastica* family of curves. Now when the length and the load are given the elastica is not entirely determinate. In fact for the same length and the same load (if sufficiently great) there exist forms having respectively 1, 2, 3. . . . inflexions. These are the curves figured in Thomson and Tait's "Nat. Phil.," part ii. p. 148, and for our present application the rod must be supposed held at the middle point of one of the bays, into which it is divided by the line of action of the load. Thus the part of the curve between the point of support and the nearest inflexion is half a bay, the rest of the curve up to the point of attachment of the load consists of an integral number of complete bays. Now although all these forms are possible there is only one which is stable, and that is the form with a single inflexion. To prove this we have to investigate the potential energy in the configuration with a single inflexion, in which the curve forms a single half bay, and in the configuration with $2n+1$ inflexions, in which the curve forms $n+\frac{1}{2}$ bays. It is not difficult to prove that in every case the latter potential energy is the greater. It follows that the figures given by Euler's "Theory of Struts" in which the rod forms a curve which is nearly a curve of sines of small amplitude crossing the line of action of the load more than once are all unstable forms. The stable form is a curve of finite curvature, which never crosses the line of action of the load.—Prof. Lloyd Tanner next made a communication on complex primes formed with the fifth roots of unity. The object of the paper is to explain a method of calculating the complex prime factors of real primes included in the form $10\mu+1$. The only published method which I have met with is due to Kummer. This is not restricted to the particular case here considered; but as it involves the determination of the G.C.M. of two complex numbers, it is probably more laborious than the method now communicated. The method adopted by Reuschle in the calculation of his tables does not appear to have been published. The process here is based on the indeterminate equation

$$X^2 - 5Y^2 = 4p.$$

A minimum solution of this equation gives the "simplest" prime factor according to Kummer's definition (*Berlin Monatsberichte*, 1870, p. 413) and solutions in which Y is a multiple of 5 give the "primary" prime factors which Kummer found it necessary to use in order to establish the general law of reciprocity. In solving the equation Lagrange's method turns out to be impracticable, and a short discussion—treated graphically—is introduced, which is sufficient to show the relations between the different solutions. These relations can be expressed in the form—

$$\begin{pmatrix} 2, & 0 \\ 0, & 2 \end{pmatrix}\left(X, \ Y\right) = \begin{pmatrix} a, & 5b \\ b, & a \end{pmatrix}\left(X', \ Y'\right)$$

and it is interesting to note the intimate connection between these matrices and the complex units. From any solution (X, Y) three numbers A_0, A_1, A_2, are found, A_0 being the integer next greater than 2X/5, and these serve to determine the values and sequence of the co-ordinates a_0, a_1, &c., in the required prime factor

$$a_0 + a_1\omega + a_2\omega^2 + a_3\omega^3 + a_4\omega^4.$$

The first condition is

$$A_0 = a_0^2 + a_1^2 + a_2^2 + a_3^2 + a_4^2.$$

The values of a have to satisfy other conditions, some of which are tested by mere inspection. To give some idea of the facility of the method from the calculator's point of view it may be stated that the determination of the prime factors of two primes selected at random in the second million (viz. 1,562,051 and 1,671,781) was completed in three hours. The only auxiliary table required is a table of squares: and if this extends to the square of 7000 it will suffice for the factorisation of all primes in the first nine millions. Tables are appended giving the simplest —and simplest primary—prime factors of all suitable primes less than 10,000. The reciprocal factors are also given after the first thousand. For the first thousand the reciprocal factors have already been published; and instead of giving these again, a comparison is indicated between the factors here given and those published in Reuschle's tables. The result of the comparison suggests that Reuschle's method of calculation was not the same as that now communicated.—The dioptrics of gratings, by Dr. J. Larmor, F.R.S. When a beam of light falls on a continuously ruled or striated surface, in addition to the principal portion that passes on and the portion that is scattered and lost by the roughnesses of the surface, there are formed a series of secondary diffracted beams that are propagated onward in oblique directions. Each of these beams is produced in the well-known manner by the union of the elements from the different striations (or homologous groups of striations), which arrive at its front in a common phase. The dioptrical discussion of such diffracted beams, that is so far as regards their geometrical properties, forms a rather simple case of the theory of the refraction of a general dioptrical pencil, which has been developed by Hamilton, Maxwell, and other writers. In the case of homogeneous wave-length λ, when the principal beam, coming from its focal lines, is refracted at the striated surface to two other focal lines, the nth diffracted beam is propagated as if it were simply refracted at a new surface formed by adding on at each point a thickness $(\mu-1)nm\lambda$ of the refracting medium in front of the original surface; where m is the number of striations counting from any arbitrary origin on the surface up to the point. The case of reflexion is included by making $\mu = -1$. As a special example, it is well known that the positions of the primary and secondary foci for conical pencils in a spherical Rowland grating, are determined by the same formulæ as hold for reflexion in a curved mirror. The treatment of the aberration at the focal lines, or the discussion of the caustic surfaces of the diffracted beams, is reduced immediately to the Hamiltonian formulæ by noting that the characteristic function of the beam is increased by the quantity $(\mu-1)nm\lambda$, exactly, in crossing the diffracting surface.—The secretary read a brief abstract of a note by Prof. L. J. Rogers on a three-fold symmetry in the elements of Heine's series.—Messrs. Greenhill, Walker, Cunningham, and the Chairman joined in the discussions on the papers.

Royal Microscopical Society, March 15.—A. D. Michael, President, in the chair.—The president said that a series of thirty-six photomicrographs had been sent to the Society of Arts, in compliance with the request read at the last meeting, for exhibition at Chicago.—An electric turntable was exhibited on behalf of Mr. Payne, of Newcastle. It consisted of a brass turntable of ordinary pattern having an electric motor fitted beneath the plate; the whole was caused to revolve by the current from a bichromate battery cell.—Dr. W. H. Dallinger gave a brief description of Prof. Bütschli's experiments on the so-called artificial protoplasm; and said in conclusion, that he could not suppose that any one looking at these forms would regard them as in any way allied to living matter. The more intimately they became acquainted with them the more sure they would become that they were only forms, and that those which appeared under a low power to be so much like tissue were under a high power seen to be minute bubbles and nothing more. He believed the movements observed would be found to be due to the effect of differences of surface tension, and that the study of them would no doubt help them to understand some of the mechanical properties of protoplasm, but they did not leave an impression that they had caused an approximation in the least degree towards the artificial production of protoplasm.—Mr. R. T. Lewis exhibited and described a new species of Aleurodes (*A. asparagi*) which had been found upon the leaves of asparagus in Natal.—Mr. T. F. Smith read a note on the use of monochromatic yellow light in photomicrography.—Prof. F. Jeffrey Bell read a note from Dr. A. M. Edwards on

a simple mode of illumination for the microscope.—Surgeon V. Gunson Thorpe's paper on the rotifera of China was read by Prof. Bell.—Dr. G. M. Giles's paper on certain cystic worms which simulate the appearances of tuberculosis was also read by Prof. Bell.—Dr. R. G. Hebb said that he had never met with any of the worms described in England. He had found nodules in the lungs of sheep, and although unable to find the worm, he had supposed it to be the cause of what he had found. —Prof. Bell thought that what Dr. Giles stated in the beginning of his paper was of considerable importance, because if the large number of animals which were killed as being tuberculous were really not so, it might be possible to prevent their destruction. There was, he imagined, a general dislike amongst most persons—except such as were fond of high game—to eating meat which swarmed with parasites of any kind; for if it was correct that the cattle in India which were reputed to be highly tuberculous were not so, it was very important that the fact should be widely made known.—The president said that he fully agreed with Prof. Bell in his remarks.—Dr. A. C. Stokes's paper on new brackish water infusoria from the United States was taken as read.

Linnean Society, March 16.—Prof. Stewart, President, in the chair.—A curious freshwater alga, growing in a perfectly spherical mass without any visible point of attachment, and described as a condition of *Cladophora*, was exhibited by Mr. A. W. Bennett, who stated that specimens had been found in English and Welsh lakes, as well as in Sweden, and that the peculiar spherical form of growth was difficult to explain. Mr. G. R. Murray suggested that it might be due to the action of a current, which would cause a continuous revolution of the mass.—Mr. R. I. Pocock exhibited a singular nest, so called, of a myriopod received from Sierra Leone, and formed of a clayey earth, which had become hardened by exposure. It was suggested that it was not a nest in the proper sense of the word, formed by the creature itself, but rather a case fashioned by ants for the purpose of entombing their enemy.—Mr. G. F. Scott Elliot gave an interesting account of the botanical results of the Sierra Leone Boundary Commission, and of the collections made by him during five months travelling. His remarks were criticised by Messrs. J. G. Baker, C. B. Clarke, W. Carruthers, and Dr. Stapf, who was present as a visitor.—Mr. J. H. Venstone described some points in the anatomy of a mollusk (*Melongona*) from recent dissections made by him, and exhibited several preparations in support of his statements. Prof. G. B. Howes bore testimony to the originality and value of the observations which in some respects were at variance with the views of the most recent writers on the subject. Messrs. G. R. Murray and Horace Monckton offered some remarks on the similarity in certain respects of the fauna and flora of the West Coast of Africa and the East Coast of South America, with reference to the statements made by Mr. Pocock and Mr. Scott Elliot.—The meeting adjourned to April 6.

Anthropological Institute, March 21.—Prof. A. Macalister, F.R.S., President, in the chair.—Dr. Tylor exhibited a collection of the rude stone implements of the Tasmanians, showing them to belong to the palæolithic or unground stage of the implement-maker's art, below that found among prehistoric times in Europe, and being on the whole the lowest known in the world. Fragments or rough flakes of chert or mudstone, never edged by grinding, but only by chipping on one surface with another stone, and grasped in the hand without any handle, served the simple purposes of notching trees for climbing, cutting up game, and scraping spears and clubs. The Tasmanians appear to have kept up this rudimentary art in their remote corner of the world until the present century, and their state of civilisation thus becomes a guide by which to judge of that of the prehistoric drift and cave men, whose life in England and France depended on similar though better implements. The Tasmanians, though perhaps in arts the rudest of savages, were at most only a stage below other savages, and do not disclose any depths of brutality. The usual moral and social rules prevailed among them; their language was efficient and even copious; they had a well-marked religion in which the spirits of ancestors were looked to for help in trouble, and the echo was called the "talking shadow." Such facts make it clear that neither antiquity nor savagery reaches to really primitive stages of human life, which belongs to a remoter past.—A paper by Prof. Politis on burial customs in modern Greece was read; also a paper on the cave paintings of Australia, by the Rev. John Mathew.

EDINBURGH.

Royal Society, February 20.—The Hon. Lord Maclaren, vice-president, in the chair. Mr. Malcolm Laurie read a paper on the anatomy of the *Eurypteridæ*. Chelicerae exist in front of the mouth in *Slimonia* and *Eurypterus*, thus making the number of cephalothoracic appendages in these forms agree with that of the arachnida in general. The presence of an epiconite on the basal joint of the walking limbs is also an arachnid character. The third to sixth free segments in *Slimonia* carry paired plate-like appendages, each of which appears to have borne one or more branchial lamellæ. There are sternites covering the whole ventral surface of each segment; *Slimonia* differing in this respect from *Eurypterus*, which, according to Schmidt, has no sternites on these segments. The suppression of the sternite of the second free segment and the reduction of its appendage to nothing but branchial lamellæ is due to the enormous development of the genital operculum which covers this region. This suppression of the second segment seems to point to a closer relation of these forms to the *Pedipalpi*, in which the same thing occurs, than to the scorpion, in which the second segment and its appendage are well developed.—The Rev. Prof. Duns discussed the early history of some Scottish mammals and birds.—Prof. Rutherford communicated a paper, by Dr. W. G. Aitchison Robertson, on the digestion of sugar in health.

March 6.—Mr. T. B. Sprague discussed a new algebra, by means of which permutations may be transformed in a variety of ways, and their properties investigated. In this algebra seven symbols of operation are used, the multiplication table being—

	r	i	p	s	t	l	m
r	1	ir	pi	$s^{-1}r$	tr	slr	mr
i	ri	1	pr	si	$t^{-1}i$	li	tmi
p	ip	rp	1	tp	sp	mp	lp
s	rs^{-1}	is	pt	s^2	ts	$s^{-1}ls$	ms
t	rt	it^{-1}	ps	st	t^2	lt	$t^{-1}mt$
l	$s^{-1}rl$	il	pm	s^2l	tl	l^2	ml
m	rm	$t^{-1}im$	pl	sm	t^2m	lm	m^2

Prof. Tait read a note on the compressibility of liquids in connection with their molecular pressure.

March 20.—Dr. D. Gill, H.M. Astronomer at the Cape of Good Hope, communicated a paper illustrated by photographs on recent progress in celestial photography. The method recently used for the determination of the sun's distance by observations of the planet Victoria was also described. A number of separate series of observations have been made—each series by itself being more trustworthy than observations made during a transit of Venus. The results indicate also that the present estimate of the mass of the moon is about one per cent. too large.—A paper was communicated by Dr. Robert Munro on a remarkable glacier lake, formed by a branch of the Hardanger-Jökul, near Eidfiörd, Norway.

PARIS.

Academy of Sciences, March 20.—M. Lœwy in the chair. —On the next solar eclipse, by M. J. Janssen.—On the preparation of a variety of swelling graphite, by M. Henri Moissan. M. Luzi has divided the varieties of graphite into two classes, according to their behaviour on treating with a little nitric acid and calcining. Those which swell up he calls graphites, and those which do not graphitites. The varieties produced ordinarily in the electric arc and by solution in iron do not swell. It can, however, be obtained in the first condition by suddenly cooling the casting in water, when the swelling graphite will be found in the more interior portions. The best way of preparing it is by means of molten platinum. About 200 gr. of platinum are fused in a carbon crucible placed in the elec-

ric furnace. When the metal fuses it gets saturated with carbon, forming a carburet mixed with free carbon, which after solidification exists in the form of swelling or true graphite. It is separated by aqua regia. The residue consists of slate-grey hexagonal crystals of density 2·06 to 2·08, burning in a current of oxygen at 575°. From 400° upwards it swells like mercury sulpho-cyanide. It is not attacked by fused nitrate of potassium, chromic acid, or hot sulphuric acid, but is rapidly attacked by warm iodic acid and fused sodium carbonate. The swelling up is attributed to the sudden liberation of heated gas due to the decomposition of a very small quantity of graphitic oxide produced under the influence of nitric acid at the expense of a trace of amorphous graphite mixed with the crystallised variety, and more easily attacked than the latter.—Researches on samarium, by M. Lecoq de Boisbaudran.—The pancreas and the nerve centres regulating the glycemic function; experimental demonstrations derived from a comparison of the effects of a removal of the pancreas with those of bulbary section, by MM. A. Chauveau and M. Kaufmann. Medullary section, preceded or followed by bulbary section, produces exactly the same effects as medullary section preceded or followed by the removal of the pancreas. As regards, therefore, the physiological action exerted upon the sugar-forming apparatus, this last operation behaves exactly like the bulbary section. Now the latter determines the super-activity of the liver by suppressing the transmission of the influence of an inhibitory centre situated in the medulla oblongata. As a necessary result, the removal of the pancreas acts in an analogous way in producing hyperglycemia and glycosuria. This operation amounts to the annihilation of the centre controlling the glycogenic function. Hence the pancreas acts upon this function by exciting the activity of this inhibitory centre, and probably also by influencing the exciting centre, which is, on the other hand, checked in its activity by the products of internal pancreatic secretion poured into the blood. The results of the whole experimental investigation on the pathogeny of diabetes are embodied in sixteen propositions.—On the distribution in latitude of the solar phenomena observed at the Royal Observatory of the Roman College during the fourth quarter of 1892, by M. P. Tacchini.—Photography of the solar corona apart from total eclipses, by M. George E. Hale.—On electric waves along fine threads; calculation of the depression, by M. Birkeland.—On initial capacities of polarisation, by M. E. Bouty.—Influence of frequency upon the physiological effects of alternating currents, by M. d'Arsonval.—Measurement of large differences of phase in white light, by M. P. Joubin. A new method of rendering visible the fringes produced by two interfering systems of waves consists in placing an anisotropic compensator upon both the groups which have traversed the interference apparatus. This compensator then receives polarised light which, before being analysed, passes through a plate of quartz with its principal section at an angle of 45° to the plane of polarisation. Such an arrangement has been carried out in one of Fizeau's apparatus for measuring expansions. It reads direct to $\frac{1}{50}$ of a micron.—On spherical aberration of the human eye; measurement of senilism of the crystalline, by M. C. J. A. Leroy. The mean aberration is a function of the age which grows slowly in young people and very rapidly after mature age, tending towards a maximum in old age. The spherical aberration of the eye also depends principally upon the crystalline and notably upon the variability of its index of refraction. In young people this variability is rapid enough to sensibly correct the aberration. It decreases with age, and tends to a limiting value which it would have if the crystalline had a uniform index throughout.—Electrical crucible for the laboratory, with directing magnet, by MM. E. Ducretet and L. Lejeune.—On a phenomenon of dissociation of sodium chloride heated in presence of a wall of porous earth, by M. de Sanderval.—On hydurilic and desoxyamalic acids, by M. C. Matignon.—Action of cotton upon sublimate absorbed in dilute solutions, by M. Léo Vignon.—Influence of the alkalinity of blood upon the process of intra-organic oxidation provoked by spermine, by M. Alexandre Pœhl.—Production of sugar diabetes in the rabbit by the destruction of the pancreas, by M. E. Hédon.—Improvement of potato-culture for industrial and forage purposes in France, by M. Aimé Girard.—On the employment of ruthenium red in vegetable anatomy, by M. Louis Mangin.—Permian fish fauna in France, by M. H. E. Sauvage.—On the manifestation, for more than six hundred years, of sudden variations of temperature on fixed dates during the second fortnight of January, by M. Dom D. Démoulin.—Destruction of trees and public health, by M. J. Jeannel.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—Laws and Properties of Matter: R. T. Glazebrook (K. Paul).—British Fungus Flora, vol. 2: G. Massey (Bell).—Text-book of Comparative Geology: Dr. E. Kayser, translated and edited by P. Lake (Sonnenschein). Beiträge zur Biologie und Anatomie der Lianen. Zweiter Theil:—Beiträge zur Anatomie der Lianen, Dr. H. Schenck (Jena, Fischer).—Œuvres Complètes de Christian Huygens, vol. 5 (La Haye, M. Nijhoff).—Statistics of the Colony of Tasmania, 1891 (Tasmania).—Meteorological Observations made at the Adelaide Observatory, &c., 1890 (Adelaide).—Lehrbuch der Entwicklungsgeschichte des Menschen und der Wirbelthiere, Dr. O. Hertwig (Jena, Fischer).—Topographische Anatomie des Pferdes. Erster Teil:—Die Gliedmassen: Drs. Ellenberger and Baum (Berlin, P. Parey).—Distribution de la Vapeur: A. Madamet (Paris, Gauthier-Villars).—Le Lait: P. Langlois (Paris, Gauthier-Villars).—Universal Atlas. Part 25 (Cassell).

Pamphlets.—Diagrams of Isothermal Lines of New South Wales.—Hailstorms: H. C. Russell.—Das Genetische System der Chemischen Elemente: W. Preyer (Berlin, Friedländer),—Further Studies of Yuccas and their Pollination: W. Trelease (St. Louis, Mo.).—Museums Association, Report of Proceedings, &c., at the Third Annual General Meeting.—The Negro in the District of Columbia: E. Ingle (Balt.).

Serials.—Memoirs and Proceedings of the Manchester Literary and Philosophical Society, vol. 7, No. 1 (Manchester).—Journal of the College of Science, Imperial University, Japan, vol. v., part 3 (Tōkyō).

CONTENTS.

THURSDAY, APRIL 6, 1893.

MATHEMATICAL ELASTICITY.

A Treatise on the Mathematical Theory of Elasticity. By A. E. H. Love, M.A., Fellow and Lecturer of St. John's College, Cambridge. Vol. I. (Cambridge: University Press, 1892.)

MR. LOVE'S treatise is the necessary complement to Todhunter and Pearson's "History of the Theory of Elasticity," in which an abstract is given of all the most important original memoirs bearing on this subject, arranged in historical order.

But the student who wishes to make himself acquainted with the works of these original authorities, by the guidance of Todhunter and Pearson's History, will find the necessity of an acquaintance with Mr. Love's work as an introduction to the elements and to the notation of the subject of elasticity.

Mr. Love has prepared an elegant and modern artillery of analysis; and he is not afraid to fire off his guns. To pursue the simile, there is no fear of the subject being obscured in the smoke of his own guns—in these days of smokeless gunpowder.

The size of the book is kept within reasonable dimensions, compared with the scale of a continental treatise, by leaving the heaviest parts of the analysis as exercises to be worked out by the trained mathematical student, to whom the work is addressed.

The author says in the preface, "I have not thought it advisable to introduce collections of examples for practice." But such collections do not exist, and the author would find it as formidable a task as that he has already carried out to attempt to construct the examples himself. In the present state of his subject any really novel example would be worthy to take rank as a new and independent theorem.

The examples which we see around us of the physical and industrial applications of the Theory of Elasticity are the best check in existence to keep the subject from becoming a mere development of pure mathematics, with such generalisations as to space of n dimensions, and based upon physical laws adopted merely because of the analytical elegance they confer, quite apart from any experimental verification.

The first five chapters are occupied with the general theory, including the analysis of strain and stress, stress-strain relations, the strength of materials, and a number of general theorems. In the analysis of strain the method of Thomson and Tait's "Natural Philosophy" has been followed, beginning with the geometrical and algebraical theory of finite homogeneous strain, deducing thence the physical state of infinitesimal strain. Hooke's law, made such a mystery of by its inventor, now becomes a necessary consequence of the expansion by Taylor's theorem of the stresses as functions of the displacements and strains, neglecting power above the first or second; and the law receives ample experimental justification in the observed isochronism of the small vibrations of elastic bodies, as exhibited by the musical notes they give out.

In the treatment of the bending of a beam and the torsion of a cylinder in Chapter VI., Saint-Venant's method has been followed, and the warping and distortion of the cross-section carefully investigated and illustrated in fig. 10, p. 156.

This warping effect is well known to engineers, though hitherto generally ignored in the mathematical treatment, as impairing the sweet simplicity of a bending moment and consequent proportional curvature resulting only from the extension and compression of the fibres, thus ignoring the shearing stresses called into play. We can now begin to perceive the reason why a beam is so much stronger and stiffer than it ought to be according to the ancient theory.

In the investigation of the torsion of a cylinder, where cross-section is a rectangle, the analysis of Thomson and Tait has been closely adhered to. Dr. Ferrers, the Master of Gonville and Caius College, has made this analysis more complete and symmetrical, and has exhibited the hydrodynamical analogies more clearly, by employing a pair of Fourier series, one proceeding by sines and cosines of multiples of x, and the other of y; each series representing separately the motion or displacement corresponding to a simple shear of the rectangular section. The elliptic function interpretation of this pair of series, in which the corresponding moduli are obviously complementary, is very interesting, but has not been pursued by Mr. Love.

Now that Prof. Karl Pearson has dedicated the first part of the second volume of the History to the "Memory of Saint-Venant," the political cloud, vaguely described in M. Bertrand's recent *éloge* of Chasles, which overshadowed Saint-Venant's official career, is clearing off, and full tribute is beginning to be paid in France to the great advances due to him.

Lamé, too, like Saint-Venant, appears to have lived in official neglect, although his method of Curvilinear Coordinates, expounded in Chapter VII., has been a powerful analytical engine for the solution of elastical problems, and his "Théorie de l'Élasticité" is a standard text-book to the present day.

The solution of the elastic deformation of a sphere, treated in Chapter X., is also due to Lamé. Mr. Love applies his analysis to the consideration of the effect of a flaw in the shape of a spherical cavity, and shows that in this case the engineer's factor of safety of 2 is the theoretically correct factor.

The most important application on a large scale of the analysis of the elastic deformation of a sphere is the investigation of the effective rigidity of the earth, considered as an elastic solid, under the action of its own gravitation, and slightly disturbed by the rotation and the tide-producing forces. Elaborate calculations and observations have been carried out by Prof. G. H. Darwin; if we could observe and measure the bodily tides in the earth, an estimate of its rigidity could be obtained. Mr. Love gives the numerical results corresponding to mean rigidities equal to those of steel and glass.

Mr. Chree's valuable investigations of the strain produced by rotation in an elastic circular disc, in a sphere or an ellipsoid, are introduced here, and receive careful analysis and interpretation.

Chapter XI. treats of the vibrations of a sphere. The free vibrations have been completely worked out by Prof. Lamb. In the forced vibrations the lag or change

 B B

of phase is the interesting subject of inquiry, as showing to what extent the "equilibrium theory" of the bodily tides of the earth, considered in the preceding chapter, can be adopted as a working theory.

Lord Kelvin has shown how the inertia of a pendulum appears reversed in sign if the point of support is actuated by a vertical vibration, when the forced and free periods are as two to one; but when the periods are made in the ratio of three or four to one, the equilibrium theory can be adopted. This principle has been employed recently by Sarrau and Vieille in the measurement of powder pressures by means of spring gauges; the free period of the spring is so adjusted in comparison with the period of the applied pressure, so that the vibrations of the spring do not make their appearance, and the indications of the gauge are the same as those for an equal statical pressure, steadily applied.

Valuable work in the discussion of particular problems of a somewhat general nature has been carried out by the late Prof. Belti, of Pisa, and continued by his disciple Cerruti; particularly also by M. Boussinesq, in his theory of "local perturbations" in an elastic solid bounded by a plane, as illustrated, for instance, in the deflection produced in a sheet of ice by a man standing on it; these questions occupy Chapters VIII. and IX.

The applications of conjugate functions in Chapter XII. introduce some interesting problems. The book concludes with the consideration of an elliptic cylinder, turned through a small angle. Something appears wanting here, as the balancing couples on the interior and exterior confocal ellipses are not brought into evidence. When the exterior ellipse becomes indefinitely large the stresses over it are evanescent, but their resultant is a finite couple. So, too, when the inner ellipse becomes the line joining the foci; in this case the Jacobian h becomes infinite at the centre, and the displacements u and v at this point require closer investigation.

It is unfortunate, as Maxwell remarked, that we have no space functions corresponding to the conjugate functions of a plane. But by the rotation of these conjugate plane curves about an axis, Waugerin has obtained a system of space co-ordinates, suitable for application to certain surfaces of revolution, and he, Mr. Hicks, and Mr. W. D. Niven, have worked out the analysis completely for certain quadric surfaces, cones, and tores.

In the questions considered in this first volume the forces which produce the elastic displacements are of moderate amount, so that the proportionality of stress to strain may be taken as true, and they act as distributed forces throughout the solid, such as gravity and the *forces of inertia* introduced by vibrations.

Mr. Love measures these forces per unit mass, and not per unit volume, as in Thomson and Tait's "Natural Philosophy," so that the component forces appear as ρX, ρY, ρZ, qualified by ρ, the density as a factor.

Cases might arise, however, say in a dynamo, where some of the forces, the forces of inertia and gravity, would be measured per unit mass, and the others, the electromagnetic forces, per unit volume; for this reason the Thomson and Tait method of measurement appears preferable, as the factor ρ can be inserted where required.

The difficulties of constructing a rational theory will turn up in the second volume, when the question of the elastic equilibrium of a lamina has to be considered, in which the stresses are due to an applied finite pressure on one side of the lamina. Mr. Basset has performed a valuable service in pointing out the insufficiency of preceding methods for constructing a theory of such an important practical question as the collapse of boiler flues (*Phil. Mag.*, September, 1892), and he might have added of the Bourdon gauge. We await with interest Mr. Love's contribution to this delicate and baffling part of the Theory of Elasticity.

In the preface of the "Treatise on Solid Geometry," by Frost and Wolstenholme, the authors, after thanking the proof-readers for their trouble, conclude by "expressing their regret that they have not escaped a large number of errors, which it will be punishment enough to them to see tabulated in an adjoining page."

Where the critic has also been a proof-reader he lays himself open to this ambiguous acknowledgment, if he points out any misprints; but we are pleased to find that the present volume, on careful re-examination, appears to be very clearly and correctly printed.

A. G. GREENHILL.

BIOLOGY AND THE MEDICAL STUDENT.

Text-book of Elementary Biology. Introductory Science Text-book Series. By H. J. Campbell, M.D. (London: Swan Sonnenschein and Co. New York: Macmillan and Co., 1893.)

THIS volume of 266 pages octavo is an ultra-elementary one, subdivided into a first part of 155 pages, which deals with generalities of plant and animal morphology and physiology, together with the principles of classification, and into a second of 111 pages devoted to the consideration of certain type organisms. With the exception of the dog-fish, which the author dismisses in four short pages, the said types are those of the examination syllabus of the Conjoint Board of the Royal Colleges of Physicians and Surgeons; and the fact that the book is the first one which has been written up to that standard invests it with a special interest. It is illustrated by 136 borrowed woodcuts, some of which are very poor and antiquated, while others are defective. Its author shows himself to be possessed of a considerable power of discretion, and his book is clear and attractive in style. It is, however, a pure compilation, for the most part from well-known text-books, as is only too apparent in certain gross errors transcribed, for example, that of the assertion that the Monotreme brains are "not convoluted"; its only novelty lies in the judicious introduction of concise and useful historical *résumés*, giving the dates, names, and achievements of epoch-making investigators. Trivial errors abound, and controversial matters of the moment are here and there dogmatically introduced, as though finally established; to wit (a) the allusion (pp. 39 and 145) to the ectoblastic origin of the segmental duct, which, so far as it may be to-day regarded as an undisputed fact, rests upon Van Wijhe's discovery of a dividing nucleus connecting it with the parent epiderma, and (β) the assumed conjugative reproduction of Amœba (p. 160). Conversely

it is refreshing to find that in this, a most elementary work, the pulmonary sacs of spiders are alluded to as "fantracheæ" (p. 105) and the lung hooks of scorpions as "chambered tracheæ" (p. 112). The author distinguishes between more general matter printed in large type, and more detailed set up in smaller, pointing out in his preface that "in reading the book for the first time the student is advised . . . to read only" the former. The fact that in some cases a knowledge of the details in question is indispensable for the appreciation of the broader statements laid down for first reading, somewhat detracts from the utility of the method employed; and in at least one case (two top paragraphs of p. 7) the sentences are so worded that the exclusion of the smaller type involves error and confusion of ideas. One of the most characteristic features of the work is its marked brevity. "A general review of the Mammalia" is essayed in eleven pages, while the "Infusoria" are despatched in one line and a word (but a cross reference to the Vorticella described in full in a subsequent chapter). No wonder then, that for want of due qualification, descriptions of things and conditions in reality individual and special should serve for those general and of broad application (as, for example, the assertion that the spiders as an order have an unsegmented cephalo-thorax, and that "all cells resemble each other when they are first formed"), and that negative characters should be occasionally employed for diagnostic purposes, to the exclusion of others of a positive and more forcible nature but requiring a more detailed declaration (*cf.* the treatment of the limbs of Primates). Some of the more lengthy descriptions are, nevertheless, inadequate and unfortunate, notably that of the sponges, which are defined (p. 85) as "the connecting link between unicellular animals on the one hand and multicellular animals on the other," and whose complex structure is illustrated by a diagram unlike anything in nature. In dealing with the vertebrate reproductive system and cloaca, the author has so mixed up details and definitions that his statements are misleading, contradictory, and in part erroneous (*cf.* pp. 155 and 264, and 135, 153, 252, and 256). In dealing with the lower plants, the existence of sieve-tubes in the marine algæ (*Macrocystis*) might with advantage be alluded to as an all-important elementary fact, and the definitions of the Thallophyta and the Pteridophyta might well be modified accordingly. Minor errors and deficiencies, such as the implied absence of sensory cells in the hydra, the too-frequent employment of the adjective "horny" in allusion to structures having no such constitution (*cf.* especially pp. 102 and 192), the confusion between the "wing" and patagium, and the definition of important orders and families in terms which in their scantiness convey no adequate meaning, will doubtless be duly corrected and made good. This notwithstanding, the book has many good points, and its clearness of style is a high recommendation; its greater subdivision, if amplified and supplemented by way of introduction of great groups not even named in the present edition (*e.g.* the Brachiopoda and Polyzoa), might be worked up into a generally serviceable volume.

The lesser subdivision of the volume chiefly merits attention for having been avowedly compiled for the examinees of the conjoint medical board above alluded to. The programme is as follows:—Amœba (5 pp.), Yeast Plant (3 pp.), Protococcus and Glœocapsa (6 pp.), Bacteria (6 pp.), Vorticella (7 pp.), Gregarinæ (5 pp.), Hydra (9 pp.), the Liver Fluke (11 pp.), Tape Worms (21 pp.), Nematoda (12 pp.), the Leech (11 pp), General Review of the Mammalia (11 pp.) = 107 pp. in all, of which 66 are devoted to animal parasites—a veritable diet of worms! We know not upon what principles this *régime* has been prescribed; but when it is considered that the doctrine of phagocytosis, which has of recent years done more than all else to advance and revolutionise medical science, is the direct outcome of comparative biological inquiry, and that its founder is a non-medical man, we confess to a feeling of astonishment. The programme itself savours of the "Technical Education" bogie of our times, than which no greater deception has ever existed. The principles of an elementary scientific training must be the same for the medical man and the mechanician, the philosopher and the plumber. Natural laws and ultimate principles are for all time and unalterable; and experience shows that the medical student whose elementary biological training embraces a comprehensive structural analysis of some small mammal (if of no lower vertebrate in addition) together with the principles of comparative morphology, working from the tree thus surveyed as a whole through the scattered leaves of his surgical anatomy, emerges a thinking man, rather than a mere pedant, as has been so often the case in the past. The chief value of biological science to the medical student is unquestionably educational. To sink this all-important aspect of his scientific training, in preference for a mere dabbling in helminthology, as we venture to think has been done in the case before us, is to neglect one of the surest safeguards for the future, and to ignore the dictates of common sense based upon experience. The attitude is indicative of a retrogressive return to the days when medicine was the only channel of approach to science, and to that order of things, the lingering relicts of which, still hovering over certain of our English-speaking Universities, to-day bar the way to the employment of all but medical graduates as responsible teachers of science in certain of their medical departments. The time is fast dawning, when in London and other great centres, the preliminary scientific training of the medical student must of necessity be imparted either in central institutions devoted to the purpose, or in no less special ones attached to the medical schools themselves. This work, if it is to be done properly and to the credit of the nation, must clearly be entrusted to trained specialists, whose business it shall be to keep abreast of the times; and by such men the text-books of the future will have to be written. The principles which have called forth the volume now under review, on the other hand, favour a professional monopoly, under which the medical practitioner will tend to usurp the functions of the trained non-medical educationalist, to the detriment of his own calling and the reversion to a well-nigh obsolete constitution. Indications of the exercise of this monopoly are abroad; but we shall be much surprised if, in the bidding for the medical student now rife, it obtains a foothold.

G. B. H.

THE MORPHOLOGY OF BACTERIA.

Contribution à l'Étude de la Morphologie et du Développement des Bactériacées. Par A. Billet, Doct. en Méd., Médécin-Major de 2e classe. (Paris: Octave Doin.)

SINCE the publication of the "Peach-coloured Bacterium," by Prof. Lankester, the subject of the morphology of the bacteria cannot be said to have received much attention from English investigators. The department of bacteriology has to a great extent been monopolised by the physician, who appears to confine himself almost exclusively to the study of the more practical bearings of the subject. It is therefore refreshing to find a surgeon-major devoting his time to a very thorough investigation of bacterial morphology.

Dr. Billet's work dates back from 1885, and was carried on for the most part in the Wimereux Laboratory under the able direction of Prof. Giard. His communications were first published in the *Bul. Sc. de la France et de la Belgique*, and the present work is a collected and revised edition of these. The work consists of some 287 pages, and includes (1) an historical introduction, which, owing to its succinctness and chronological sequence, will be found of great use to the general bacteriologist; (2) a minute description of the life histories of *Cladothrix dichotoma* and *Bacterium parasiticum*, and of two new species named by Dr. Billet, *Bacterium Balbiani* and *Bacterium osteophilum*; (3) a very large bibliographical index embracing some 662 references; (4) a very beautiful series of drawings.

The author briefly sketches the progress of morphology from the time of the doctrine of immutability of Cohn and that of pleomorphism of Prof. Lankester, Cienkowski, and Zopf. He shows how C. Robin (1847), in his wonderfully interesting work, pointed to an affinity between certain bacteria, his *Leptothrix baccalis*, for instance, and certain filamentous algæ, the Leptothrix of Kützing (1843); how, after the lapse of twenty-six years, Prof. Lankester (1873 and 1876), determined, in his well-known *Bacterium rubescens*, the coexistence of micrococcal, bacillary, and spirillar forms; and finally, how the theory of the "form phases" became further elucidated by Cienkowski in 1887 in the "Morphologie der Bakterien," and by Zopf in 1871 in his "Genetische Zusammenhang von Spaltpilzformen." The latter observer describes in the life history of the higher bacteria, coccal, bacteroid, bacillary, vibrio, spirillar, leptothrix, and zooglea forms; the *Clathrocystis roseo-persicina* of Cohn becomes the zooglea phase described in *Bacterium rubescens* of Lankester, or more correctly, of the higher *Beggintoa roseo-persicina.* Starting with the above series of form phases, the author ingeniously consolidates and groups them into four stages, viz.:—1. The *filamentous*, in which the bacteria are associated into larger and shorter filaments. 2. The *dissociated* stage in which the elements become free and motile, and assume the well-known coccal bacteroid and other forms. 3. The *interlacing* stage—*état enchevêtré*—where the elements interlace with one another. 4. A *zooglea* stage, in which the elements loose their movements and aggregate themselves into certain definite forms. The author goes on to show how definite and characteristic are these groupings in the case of the organisms which he has examined (see above). He points out that their presence or absence depends upon surrounding conditions—media, temperature, &c. But he further widens the whole question in seeking to show that in the less highly developed bacteria there are traces of the form phases and form groupings of the more morphologically perfect organisms. In this connection he briefly brings together the observations which have been made upon the life history of the lower bacteria. Thus the encapsulation observed in the pneumococci, streptococci, tubercle, and anthrax bacilli, sarcinæ, &c., &c., may correspond to the zooglea stage, for he recognises both pneumococcal, merispomedia, and sarcina forms in his zooglea stage. He regards the zooglea as protective, and forming when the medium is becoming exhausted. We may add that in the animal tissues encapsulation often appears dependent upon the resistance offered by the tissues. He further points out that the zooglea is often pigmented.

In describing the life histories of his bacteria, Dr. Billet makes some interesting remarks. Thus, he is inclined to believe that the cilium of the vibrio form is nothing else than the residuum of the inner coat, and that it is formed during the process of segmentation by a drawing out and attenuation of the inner coat, like, for example, when a glass rod is drawn out in a flame. As many vibrios move about which have no cilia, he agrees with Van Zieghem that the bacterial element has a proper movement of its own, which is not dependent upon a cilium, and he believes that the cilium of the Bacteria is quite a different thing from the cilium of zoospores. He carefully describes the movements of the vibrio forms, and adds that they are greatly accentuated by a powerful light, a point first observed by Engelmann, in his *Bacterium photometricum.* He also states that the passage from the rectilinear forms to the less curved (vibrio) and more curved (spirilla) forms, depends upon the degree of temperature and amount of putrefaction; the greater the latter the more the twisted and appendiculate forms. He concludes by giving the evidence in favour of a relationship between the Bacteria and the Algæ; the relationship appears great in the case of the organisms which he describes, but probably if he had studied Actinomyces he might have similarly found very many points in favour of a relationship with the mycelial fungi.

RUBERT BOYCE.

OUR BOOK SHELF.

Introductory Modern Geometry of Point, Ray, and Circle. By W. B. Smith. (London: Macmillan and Co., 1893.)

THIS work of Prof. Smith's has a "very practical purpose," viz. "to present in simple and intelligible form a body of geometric doctrine, acquaintance with which may fairly be demanded of candidates for the Freshman class" of the Missouri State University. It is shaped on the lines of such modern works as those by Newcomb, Halsted, and Dupuis, to refer to English text-books only; but it most nearly resembles in some parts the excellent little manual "on congruent figures," by Prof. Henrici. "The work asks to be judged, at least in its name, according to (the) spirit of modern geometry, and not according to the letter."

It is hard at this date to write anything new on the subject of elementary geometry, and for the class addressed by the author it is not desirable, but the well-known facts may be treated in very diverse ways: in this case there is a novelty and freshness which must commend the treatment of them to all intelligent students. Take this "precise definition" of a plane: Take two points A and B and suppose two equal spherical bubbles formed about A and B as centres. Let them expand, always equal to each other, until they meet, and still keep on expanding. The line where the equal spherical bubbles, regarded as surfaces, meet, has all its points just as far from A as from B. As the bubbles still expand, this line, with all its points equidistant from A and B, itself expands and traces out a *plane* as its path through space. Hence we may define the *plane* as the region (or surface) where a point may be, that is, equidistant from two fixed points. . . It is evident that the plane, as thus defined, is reversible. . . The superiority of this definition consists in its not only telling what surface the plane is, but also making clear that there actually *is* such a surface. Thence our author readily derives the notion of the *ray* (anglicè, straight line: a *tract* being a part bounded by end-points).

This manner of illustration occurs repeatedly, and adds, we think, much to the interest of the book.

As a specimen of the mode of proof employed we take what is equivalent to part of Euc. i. 5. *Data*. ABC, an isosceles triangle, AB its base, AC and BC its equal sides (here we may remark the figure is badly drawn: a similar remark applies to figures on pp. 60 and 91). *Proof*. Take up the triangle ABC, turn it over, and replace it in the position BCA. Then the two triangles ACB and BCA have the equal vertical angles, C and C, also the side AC = BC (why?) and BC = AC (why?); hence they are congruent (why?), and the $\angle A = \angle B$.

In the more elaborate proofs there is a larger crop of "whys," and in some cases the interrogation is answered by the author.

The amount of ground covered is considerable, and yet, as we have gone through the whole of the text, it is so clearly opened up that the intelligent student, to whom we have previously referred, should be able to master it all, and successfully grapple with the well-chosen exercises which are arranged in fitting places throughout the book. "These exercises have been chosen with especial reference not so much to their merely disciplinary as to their didactic value, the author being persuaded that quite as good exercise may be found in going somewhither as in walking round the square."

We have no hesitation in heartily commending Prof. Smith's introduction to teachers and pupils as an excellent one, and this we vouch, adapting the language of the learned counsel cited by Bailie Littlejohn, *nostro periculo*.

Primer of Horticulture. By J. Wright. (London: Macmillan and Co., 1893.)

THIS primer contains the substance of ten lectures delivered by Mr. Wright for the Surrey County Council. Besides the lectures, some sets of questions, asked after the lectures, are given together with the answers to these questions.

The primer is eminently practical, and is sure to prove very useful both to gardeners and to students. It cannot, however, be considered quite free from errors, and a careful revision would increase its value.

Sometimes the text is rather loose.

On p. 54 the word *pistil* is used indefinitely, sometimes meaning the style and at others the whole gynœcium.

Speaking of phosphatic manures on p. 64 the author says:—

"Mineral superphosphate is ground coprolite treated with sulphuric acid.

"Coprolite is antediluvian petrified manure, of which there are large beds in the Eastern Counties. It is fairly active, yet sustaining.

"Thomas's phosphate powder, or basic slag— . . . . is composed of 15 to 25 per cent. of phosphoric acid and about 45 per cent. of lime. It is not very quick in action, but lasting in effect."

From this description one cannot get much idea of the relative values of these three phosphatic manures, and basic slag suffers by comparison with ground coprolite. Practical experience shows that basic slag has a much higher value than ground coprolite as a manure, and has, moreover, an additional value as a check upon wireworm.

Again, on p. 77, the description of the fungus causing potato disease (phytophthora infestans) is scarcely accurate. In describing the aerial hyphæ which spring from the mycelium in the leaves and push their way through the stomata, the author says:—

"These stem-growths of the fungus produce 'fruit'-spores (DD) in cells (Oogonia), that divide (F) and liberate the active agents in reproduction, tailed zoospores (G) which float in the air, and swim in the moisture, dew, or rain, on potato leaves." The letters in parentheses refer to fig. 18, p. 79. Neither text nor description below fig. 18 is correct. What Mr. Wright calls oogonia are really conidia, and what he calls conidia (F in fig. 18) represent the formation of an oospore from oogonium and antheridium. We must also dissent from the author's views on zoospores floating in the air.

Apart from these defects the primer is well worthy of perusal, and will no doubt meet with success. The practical part is very well done, and this is, of course, the most essential part of the book. WALTER THORP.

Ornithology in relation to Agriculture and Horticulture. Edited by John Watson. 220 pp. (London: W. H. Allen, 1893.)

THIS book contains a series of papers by well-known writers. The chief interest will gather around chapters iii. to vii. inclusive, which treat of the common sparrow. The trial of the sparrow is opened very ably by Mr. Chas. Whitehead (for the prosecution). He is well supported in the next chapter by Miss Eleanor A. Ormerod. These two writers for the prosecution will have the support of the vast majority of agriculturists in England, and their arguments contrast favourably with the less practical defence put forward in the two succeeding chapters by the Rev. F. C. Morris and the Rev. Theodore Wood.

Chapter VII. is written by J. H. Gurney, Jun., and from the result of 755 dissections he draws up a table showing that "in England about 75 per cent. of an adult sparrow's food is corn, chiefly barley and wheat, with a fair quantity of oats." Nobody with experience of grain-growing in England will deny that the sparrow is a terrible pest, and it is time that a movement be made not towards exterminating the troublesome bird, but towards reducing its numbers to normal limits.

Chapter IX. is an interesting defence of the rook, much of which defence this bird merits. It is written by O. V. Aplin, who also contributes a very useful chapter on miscellaneous small birds. WALTER THORP.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Vectors *versus* Quaternions.

HAVING a vivid recollection of the pleasure I derived from Prof. Gibbs's attacks upon the quaternionic system in the rather one-sided discussion that took place about two years ago in this

journal, I have delayed replying to the letters of Profs. MacAulay and Tait, from an expectation that Prof. Gibbs would have something to say. In this I have not been mistaken; and, as there is a general agreement between us on the whole, I have merely to add some supplementary remarks. Prof. MacAulay refers to me as having raised the question again. I can assure him it has never been dropped. Apart from the one-sided discussion, it has been a live question with Prof. Gibbs and myself since about 1882, and is now more alive than ever. I cannot help thinking that Prof. MacAulay's letter was overhastily written, and feel sure that if he knew as much about the views and methods of those to whom he appeals as he does about Quaternions, he would have written it somewhat differently, or perhaps not have written it at all, from a conviction of the uselessness of his appeal. There is no question of suicide with us; on the contrary, quite the reverse. I am asked whether the "spoonfeeding," as he terms it, of Maxwell, Fitzgerald, &c., is not good enough for me. Why, of course not. It is quaternionic, and that is the real point concerned. Again, he thinks nothing of the inscrutable negativity of the square of a vector in Quaternions; here, again, is the root of the evil. As regards a uniformity of notation amongst antiquaternionists, I dare say that will come in time, but the proposal is premature. We have first to get people to study the matter and think about it. I have developed my system, such as it is, quite independently of Prof. Gibbs. Nevertheless, I would willingly adopt his notation (as I have adopted his dyadical notion of the linear operator) if I found it better. But I do not. I have been particularly careful in my notation to harmonise as closely as possible with ordinary mathematical ideas, processes, and notation; I do not think Gibbs has succeeded so well. But that matters little now; the really important thing is to depose the quaternion from the masterful position it has so long usurped, whereby the diffusion of vector analysis has been so lamentably impeded. I have been, until lately, very tender and merciful towards quaternionic fads, thinking it possible that Prof. Tait might modify his obstructive attitude. But there is seemingly no chance of that. Whether this be so or not, I think it is practically certain that there is no chance whatever for Quaternions as a practical system of mathematics for the use of physicists. How is it possible, when it is so utterly discordant with physical notions, besides being at variance with common mathematics? A vector is not a quaternion; it never was, and never will be, and its square is not negative; the supposed proofs are perfectly rotten at the core. Vector-analysis should have a purely vectorial basis, and the quaternion will then, if wanted at all, merely come in as an occasional auxiliary, as a special kind of operator. It is to Prof. Tait's devotion to his master that we should look for the reason of the little progress made in the last 20 years in spreading vector-analysis.

Now I have, in my turn, an appeal to make to Prof. MacAulay. I have been much interested in his recent R. S. paper. As the heart knoweth its own wickedness, he will not be surprised when I say that I seem to see in his mathematical powers the "promise and potency" of much future valuable work of a hard-headed kind. This being so, I think it a great pity that he should waste his talents on such an anomaly as the quaternionic system of vector analysis. I have examined a good deal of his paper, and can find nothing quaternionic about it except the language concerned in his symbols. On conversion to purely vectorial form, I find that it is greatly improved. I would suggest that he give up the quaternion. If he does not like my notation, or Prof. Gibbs's, or Prof. Macfarlane's, and will invent one for himself, it will receive proper consideration. He will greatly extend the sphere of his usefulness by the conversion. A difficulty in the way is that he has got used to quaternions. I know what it is, as I was in the quaternionic slough myself once. But I made an effort, and recovered myself, and have little doubt that Prof. MacAulay can do the same.

Passing to Prof. Tait's letter, it seems to be very significant. The quaternionic calm and peace have been disturbed. There is confusion in the quaternionic citadel; alarms and excursions, and hurling of stones and pouring of boiling water upon the invading host. What else is the meaning of his letter, and more especially of the concluding paragraph? But the worm may turn; and turn the tables.

It would appear that Prof. Tait, being unable to bring his massive intellect to understand my vectors, or Gibbs's, or Macfarlane's, has delegated to Prof. Knott the task of examining them, apparently just upon the remote chance that there might possibly be something in them that was not utterly despicable. Prof. Knott has examined them, and has made some remarkable discoveries. One of them is that those vector methods in which the quaternion is not the master lead to formulæ of the most prodigious and alarming complexity. He has counted up the number of symbols in certain equations. Admirable critic!

Now, since this discovery, and Prof. Tait's remarks, are calculated to discourage learners, I beg leave to say, distinctly and emphatically, that there is no foundation for the imputation. Prof. Knott seems to have found a mare's nest of the first magnitude; unless, indeed, he is a practical joker, and has been hoaxing his venerated friend. Speaking from a personal knowledge of the quaternionic formulæ of mathematical physics, and of the corresponding formulæ in my notation and in Prof. Gibbs's, I can say definitely that there is very little to choose between them, so far as mere length goes. Perhaps Prof. Knott has been counting the symbols in a Cartesian formula, or in a semi-cartesian one, or some kind of expanded form. I do not write for experts who delight in the most condensed symbolism. I do not even claim to be an expert myself. I have to make my readers, and therefore frequently, of set purpose, give expanded forms rather than the most condensed.

But so far as regards the brief vector formulæ, I find that the advantage is actually in my favour. I attach no importance to this, but state it merely as a fact which upsets Profs. Knott and and Tait's conclusions. It is desirable that I should point out the reason, otherwise the fact may not be believed. In common algebra there is but one kind of product of a pair of quantities, say F and v, which is denoted by Fv. In vector algebra there are two kinds of products. One of these closely resembles the usual product, whilst the other is widely different, being a vector itself. Accordingly, to harmonise with common algebra, I denote the scalar product by $\mathbf{Fv}$. It degenerates to Fv when the vectors have the same direction. Now, since the quaternionists denote this function by $-\mathrm{S}\mathbf{Fv}$, which is double as long, whilst $\pm\mathbf{Fv}$ becomes $\mp\mathrm{S}\mathbf{Fv}$, it is clear that there must be an appreciable saving of space from this cause alone, because the scalar product is usually the most frequently occurring function.

But there are other causes. The quaternionic ways of specialising formulæ are sometimes both hard to read and lengthy in execution. Look at $\mathrm{S}\,.\,\mathrm{U}\alpha\mathrm{U}\rho\mathrm{S}\,.\,\mathrm{U}\beta\mathrm{U}\rho$, which I see in Tait's book. I denote this by $(\alpha_1\rho_1)$ $(\beta_1\rho_1)$, or else by $\alpha_1\rho_1\,.\,\beta_1\rho_1$. Tait is twice as long. But the mere shortness is not important. It is distinctness that should be aimed at, and that is also secured by departing from quaternionic usage. Examples of shortening and clarifying by adopting my notation may be found on nearly every page of Tait's book.

Consider, for example, rotations. Quaternionists, I believe, rather pride themselves upon their power of representing a rotation by means of a quaternion. Thus, $\mathbf{b} = q\mathbf{a}q^{-1}$. The continued product of a quaternion q, a vector $\mathbf{a}$, and another quaternion q^{-1}, produces a vector $\mathbf{b}$, which is $\mathbf{a}$ turned round a certain axis through a certain angle. It is striking that it should turn out so; but is it not also a very clumsy way of representing a rotation, to have to use two quaternions, one to pull and the other to push, in order to turn round the vector lodged between them? Is it not plainer to say $\mathbf{b}=r\mathbf{a}$, where r is the rotator? Then we shall have $\mathbf{ac}=\mathbf{a}rr'\mathbf{c}=r'\mathbf{a}r'\mathbf{c}=$&c., if r' is the reciprocal of r. Then Prof. Tait's $\mathrm{V}q\mathbf{a}q^{-1}q\phi\,(q^{-1}\mathbf{b}q)\,q^{-1}$ is represented by $\mathrm{V}r\mathbf{a}r\phi r'\mathbf{b}$. See his treatise, p. 326, 3rd edition, and note how badly the $q\,(\quad)\,q^{-1}$ system works out there and in the neighbouring pages.

What, then, is this rotator? It is simply a linear operator, like ϕ. It is, however, of a special kind, since its conjugate and its reciprocal are one, thus $rr'=1$, or $r'=r^{-1}$. Far be it from me to follow Prof. Tait's example (see his letter) and impute to him an "imperfect assimilation" of the linear and vector operator. What I should prefer to suggest is that his admiration for the quaternionic mantle is so extreme that he will wear it in preference to a better-fitting and neater garment. If we like we can express the rotator in terms of a quaternion, in another way than above, though involving direct operations only. But I am here merely illustrating the clumsiness of the quaternionic formulæ in physical investigations, and their unnaturalness, by way of emphasising my denial and disproof of the charge made by Prof. Tait against vectorial methods. The general anti-quaternionic question I have considered elsewhere.

Paignton, Devon, March 24. OLIVER HEAVISIDE.

Severe Frost at Hongkong.

The occurrence of severe frost at moderate elevations within the Tropics must be rare. It seems worth while therefore to place on record in the columns of Nature some portion at least of an official report on the low temperature which (as was stated in Nature last week) occurred at Hongkong between the 15th and 18th of January:

Botanic Gardens, Hongkong, February 4, 1893.

Sir,—The unprecedented cold weather which the region about Hongkong was recently subjected to calls for some notice by this department. Records of experiences of meteorological phenomena such as we have just had besides being of passing interest are so frequently of use in practical dealings with various subjects that for this reason opportunities to record unusual phenomena should not be neglected. It does not, however, come within the province of this department to go much further into the meteorological aspects of the subject than is demanded in connection with its injurious effects on vegetation.

(2) After a period of ordinary Hongkong dry, cool weather rain fell on January 13, and continued daily up to the 16th instant. In the gardens, at 300 feet above sea level, the following quantities of rain were registered with a Glaisher's rain gauge:—

January 14	.14
„ 15	.35
„ 16	.46
„ 17	.45

(3) On the 15th instant the temperature fell in the afternoon to 39° F., at 350 feet above sea level. On the 16th, at 9 a.m., it stood at 35°. On the 17th the thermometer stood at 31° at 9 a.m., which was the lowest temperature observed at the Gardens. During this period the sky was overcast except for a short time about noon on the 17th, but on the morning of the 18th it was clear and the sun shone brightly throughout the day, the temperature having risen to 43° at 4 p.m.

(4) Unfortunately there are no official records of temperature at Victoria Peak, 1818 feet above sea level, but, by such information as could be obtained from private observers in the hill district and observations made here, it seems that the temperature must have fallen at the summit to about 25° or 24° F.

(5) On the river at Canton, and between this port and that place, low temperatures were recorded in the reports of the steamships *Powan* and *Honam*. They gave—

January 16 at 1 A.M. 23° about 28 miles below Canton.
„ „ at 10 A.M. 26° about 25 miles from Hongkong.
„ „ at 1 P.M. 25° at Canton.
„ 18 at 10 A.M. 28° about 25 miles from Hongkong.

I am indebted to the Office of the Hongkong, Canton, and Macao Steamboat Company for these returns.

(6) On the peninsula of Kowloon the cold appears to have been greater than in Hongkong; ice was seen on pools of water in the roads within fifty feet of sea-level, and at the Kowloon Docks ice was observed at the bottom, thirty feet below sea-level, of an empty dock.

(7) In the harbour the rigging of ships was coated with ice.

(8) Since the records began in 1884 the temperature has not fallen, until now, at the observatory, below 40° F. I remember on one occasion, I think about seventeen years ago, ice was found at Victoria Peak, but there is no record within my experience, which extends back nearly twenty-two years, when ice was observed below 1700 feet altitude.

(9) The continued low temperature combined with fall of rain from an apparently warmer stratum of air above, resulted in the formation of ice varying in quantity from a thin coating on the upper leaves of pine trees growing at 300 feet above sea level, to a thick encasement of perfectly transparent solid ice of 5½ inches in circumference on the blades and bents of grass at the summit of Victoria Peak. The grass bents themselves, which were the foundation on which the ice accumulated, were not more than an eighth of an inch in diameter, yet the formation of ice was so gradual that with the enormous accumulation of ice, which became its own support, the bents retained their natural upright, or but slightly pendent position. These large accumulations of ice were on the windward side of the hill where rain drifted, but even on the lee side the average coating of ice was about 3 inches in circumference.

(10) Evergreen shrubs and trees carried on their leaves solid coverings of ice ⅜ of an inch in thickness. The great weight of this ice caused the branches of trees to assume a pendent form, the strain in many cases causing the limbs to snap off with a crash. All vegetation throughout the hill regions of the Colony was thus covered with ice, as were also most other objects. Telegraph and telephone wires from Victoria Gap upwards were covered with ice ⅜ of an inch in thickness, and, in addition, carried icicles as much as three inches in length as close as they could be packed side by side. This caused many of the telephone wires to break, and the iron post at Victoria Gap which supported them was snapped off a few inches above the ground.

(11) The windward sides of the walls of the look-out house at the Peak were from top to bottom covered with perfectly trans parent ice ⅜ of an inch in thickness.

(12) All the hills on the mainland and Lantao island were likewise white with ice, one of the hills (3147 feet) of Lantao having what appeared to be snow for some few hundreds of feet down from its summit. As early as the evening of January 15 the summit of Taimoshan (about 3300 feet) on the mainland had assumed a whitish appearance, presumably from ice or snow.

(13) The effect of the extremely low temperature on vegetation has been disastrous.

(15) The damage in the gardens consist chiefly in the injury or destruction of leaves, but some plants are quite killed, these being natives of much warmer regions than Hongkong. Many of the decorative plants which were not killed will be months before they can regain their ornamental appearance.

(16) Every possible precaution was adopted to minimise the effect of the cold. The plant-houses, which are provided with screens merely to produce shade, were all matted in and the roofs covered with straw. In spite of these precautions, however, many plants suffered very severely. Of ferns in the houses *Polypodium Heracleum* and *Adiantum tetradactylon* suffered most, other kinds being but little affected.

(17) In the orchid-house, which was covered with mats and straw, all our best orchids have suffered very greatly, many being entirely killed while others were so much injured that, even if they survive, it may be some years before they regain their previous luxuriant state. A healthy plant, received from Calcutta several years ago, of *Dendrobium aggregatum*, is apparently killed, while plants of the same species growing by its side, and also others on trees where they had no shelter, which I collected ten years ago on the Lo-fan mountains, about sixty miles from Canton, have escaped unharmed. This seems to show the capability of the plant in adapting itself to colder regions than it is generally found in.

(19) The highest point of the Gardens is 320 feet above sea-level, the lowest part 175 feet. Some plants of the same kinds which were damaged at the upper portions were uninjured at the lower parts of the Gardens.

(20) Of exotic trees planted on the hills *Albizzia Lebbek*, *Aleurites triloba* (candle-nut-tree) and *Eugenia Jambos* (the rose-apple-tree) had all their leaves killed at and upwards of 600 feet above sea-level. Trees of the rose-apple at about 800 feet altitude have been entirely killed.

(21) At 600 feet altitude indigenous plants began to be affected, the injuries increasing with higher altitude until at about 900 feet when the extreme limit of low temperature which some plants could bear was reached, and death ensued. Most of these are tropical plants of which Hongkong, Formosa, the Luchu Islands in the Far East, and Sikkim and Himalaya in India are the northern limits of the geographical area from which they have been recorded. Of the plants killed or injured, *Ficus Harlandi*, Benth., *Gordonia anomala*, Spreng., and *Garcinia oblongifolia*, Champ, are known only from Hongkong. Although many of our indigenous plants have not been yet discovered elsewhere, it is to be expected that when China is better known they will be found over a larger area than the restricted one of this island. The fact of the above named plants having succumbed to the late frost indicates that when they are discovered elsewhere they will be found southward of Hongkong.

(22) Considerable damage to vegetation seems to have been caused about Canton, where the alluvial lands are highly culti-

vated. The Rev. Dr. B. C. Henry, in a letter dated January 26, informs me that "the destruction of vegetation about Canton has been very great. The banana plantations are ruined, and the bamboos have suffered. The *Aleurites triloba* look all shrivelled up, while Begonias, Euphorbias, Crotons and scores of others are simply destroyed." What Dr. Henry reports indicates severer weather at Canton than here, *Aleurites triloba* leaves being shrivelled up at Canton, while they are here at 300 feet altitude uninjured, but at 600 feet they are affected, and completely destroyed a little higher up the hill.

(23) Accompanying this report are six photographic views which were taken on January 16 showing the ice at various places in the Peak district. It is somewhat difficult to represent ice in photographs, as bright light has much the same effect as ice which owes its white appearance merely to reflected light, but it will be understood that the white in these views is produced by ice. CHARLES FORD,

Superintendent Botanical and Afforestation Department.

HON. G. T. M. O'BRIEN. C.M.G.,
Colonial Secretary, &c.

The importance of such facts as these in connection with geographical distribution can hardly be overrated. It is customary to compare the range of a plant with the corresponding mean annual temperature. But it is obvious that the exterminating effect of occasional low temperature must override every other condition. An island is often the last refuge of a species not found elsewhere. Such a frost as occurred in Hongkong would erase the Double Cocoa-nut in all probability from the face of creation, if it occurred in the Seychelles. In any case islands are not easily restocked except with littoral vegetations and the trees distributed by carpophagous birds. It seems evident therefore that the geographical distribution of plants may still be influenced by causes which are catastrophic in their nature. Of this, although not from cold, there is already a striking illustration in the simultaneous destruction of the entire forest vegetation which at one time covered the island of Trinidad in the South Atlantic. Mr. Knight, in the account which he has given in the "Cruise of the Falcon," conjectures that the cause was more probably volcanic than a long drought.

The wave of cold which affected Hongkong (or at any rate the atmospheric conditions which produced it) seems to have been tolerably extended in its range. My friend, Dr. Trimen, writes to me on February 6 from Ceylon:—

"We are having a wonderfully fine and dry time here, with extraordinary cold mornings. Here at Pecadeniya we have been registering at 6 a.m. 53° and 54° F., the lowest ever previously known being a little below 60°. The middle of the day is very hot. Hakgala has been getting frost for the first time on record."

He does not give any dates; but the two exceptional circumstances are sufficiently near together to make it probable that some common cause produced them both.

W. T. THISELTON-DYER.

Royal Gardens, Kew, March 28.

P.S.—Since writing the above I have received from the Colonial Office the accompanying report on the weather of January from the Hongkong Observatory.—[W. T. T.-D.]

The mean temperature was below the average from the 14th to the 24th. The coldest day (air 35°·2, damp bulb 32°·8) was the 16th. The lowest mean temperature of the damp-bulb thermometer occurred on the 17th (air 36°·2, damp bulb 30°·9). Circumstances were anti-cyclonic, with probably abnormally slight decrease of temperature with height. Snow-storms were reported from China to the north and east of the colony. From Macao snow was reported, but that appears to have really consisted of small-sized hail, which fell for four hours. Neither snow nor hail were seen in Hongkong, but the tops of the hills appeared to be covered by snow or hoar-frost. Water exposed in buckets or in pools was several mornings found covered with ice about ¼ inch thick, and a few hundred feet above sea-level both the grass and branches of trees, being cooled below the temperature of the air (which did not fall below freezing-point) owing to evaporation and radiation, were encased in unusually clear and transparent ice without any appearance of crystallisation. As far south as the Straits Settlements the cold was felt, but in a less degree. The temperature appears not to have fallen below 70° in Singapore. At sea strong northerly breezes were observed during the greatest cold. The colony was sheltered by the mainland, and only light northerly breezes were registered till the 20th, when the wind backed to west. It veered to east on the 21st. During the coldest days the pressure was from one to two-tenths of an inch of mercury above the mean. The sky was overcast, but cleared on the evening of the 17th. Owing to radiation the extreme temperatures occurred after this epoch: the lowest air-temperature 32°·0 about 7 a.m. on the 18th, and the lowest damp-bulb temperature 27°·7 about 2.30 a.m. on the same day. W. DOBERCK, Director.

Hongkong Observatory, February 1.

Mr. Preece on Lightning Protection.

IN the recent Presidential Address to the Institution of Electrical Engineers by Mr. Preece, I find the following reference to myself.

"Prof. Oliver Lodge has . . . endeavoured to modify our views as to the behaviour of lightning discharges, and as to the form of protectors, but without much success. His views have not received general acceptance, for they are contrary to fact and to experience."

I was quite prepared to laugh at this with the rest, but I find that the general and semi-scientific public are apt to take Mr. Preece's little jokes, of which there are many towards the end of this address, as serious and authoritative statements of scientific fact. And it has been represented to me that unless I take some notice of the above, it may be assumed that I wish silently to withdraw from an untenable position without acknowledging having made a mistake.

Indeed, I have already been questioned by a scientific worker as to whether I accepted the above statement as in any sense corresponding to truth.

My reply is that so far was I from that attitude, that I did not suppose that the statement was either meant or would be taken seriously.

The broad question of scientific fact is this:—Given an electrostatic charge at high potential, can the potential be reduced to zero most quietly and safely by a good conductor or by a bad one?

The old lightning-rod doctrine (or drain-pipe theory) said, by an extravagantly good one. I say, by a reasonably bad one. If you employ too good a conductor the mean square of current is appallingly strong, and all manner of dangerous oscillations are set up; whereas in a bad conductor the discharge can be more nearly dead-beat. These oscillations have been experimentally and mathematically demonstrated in a great variety of ways, the unexpected and distinct effects they are able to produce have been displayed, and Messrs. Whittaker have published for me a large book about them.

Some critics have sensibly objected that the book is too big, but I am not aware of any scientific authority who controverts my position.

If Mr. Preece only means that these views regarding lightning and its dangers are not yet practically accepted by the great British Telegraphic Department, that is, I admit, perfectly true.

OLIVER LODGE.

The Author of the Word "Eudiometer."

FOR some time past I have been endeavouring to find out the originator of the name eudiometer, which is now applied to the measuring tubes used in gas analysis, and possibly the result of the search may be of interest to some of the readers of NATURE.

Naturally my first resort was to text-books and dictionaries, but although the derivation of the word is sometimes given, the name of the author is not stated.

I had great hopes that the third edition of the "Encyclopedia Britannica," published in 1797, would contain the desired information, for the article "Eudiometer" must have been written not long after the invention of the instrument, but it merely calls it "an instrument for observing the purity of the atmospherical air." Descriptions of many forms of eudiometer follow.

The New English Dictionary gives the derivation and the first quotation is "1777. De Magellan (*title*), Glass apparatus for making mineral waters......with the description of some new Eudiometers"; another is "1807. Pepys. *Eudiometer* in *Phil.*

Trans. xcvii. 249. Known quantities of the air to be tried, and of nitrous gas being mixed, were admitted......into a graduated tube, which he [Priestley] denominated a eudiometer." This seems to point directly to Priestley as the author of the name as he certainly was the author of the process. (It may be mentioned in passing that, in this paper, Pepys describes the method of calibrating eudiometers, by pouring in equal quantities of mercury from a tube closed at one end and with the mouth ground flat, against which a piece of plate glass is pressed in order to obtain an exact measure of the mercury.)

With these directions I searched in the library of the Royal Society and found Magellan's book; but he uses the name eudiometer as if it were well known. Mr. White, the librarian, very kindly interested himself in the matter and found in Priestley's book, "Observations on different kinds of Air," a statement that he had received from Landriani one of his eudiometers together with a description that he asks Priestley to print, but the latter excuses himself on the ground that it would not be convenient for him to publish the letter at that time. Mr. White found the title of a book by Marsilio Landriani, "Ricerche fisiche intorno alla salubrità dell' aria" (Milano, 1775, 8°). It is not in the libraries of the Royal or of the Chemical Society, and the title does not appear in the catalogue of the library of the Royal Institution, but last week I found the book at the British Museum. On page viii. of the Introduction there is a paragraph of which the following is a translation: "The account of the discovery of nitrous air and of some of its principal properties is briefly set forth, certain defects of Priestley's apparatus are removed, and there is added a detailed description of the *Eudiometer*, for that is the name which I give to my little instrument, from *Eudios*, a Greek word signifying goodness of the air (bontà dell' aria) accompanied by the more useful precautions for its construction." There are some plates at the end of the book containing drawings of the apparatus, and one of them is marked "Eudiometro 1775." This seems to leave it without a doubt that it is to Landriani that we owe the word.

Next as to its exact meaning: by tradition we have been taught that the eudiometer is an apparatus for measuring the goodness of air, and this is obviously what was intended by Landriani. The New English Dictionary derives it from εὔδιος clear (weather) and μέτρον; Roscoe and Schorlemmer derive it from εὐδία, fine weather, and μέτρον; these meanings of the Greek words are no doubt correct, and the name would seem to be more applicable to some kind of weather glass, a signification which the above quotation shows could hardly have been in Landriani's mind. HERBERT MCLEOD.

Cooper's Hill, March 21.

Blind Animals in Caves.

ALTHOUGH in my previous letter I did not give evidence directly supporting the proposition that blind cave-animals are born or hatched with relatively well-developed eyes, that thesis is a good deal more than a mere supposition, as Prof. Lankester calls it. Nor did I, as Prof. Lankester asserts, proceed to state that no such fact is known or recorded. The condition of the eyes in the newly-born young of the viviparous Amblyopsis, or other cave-fishes, does not appear to have been investigated, although living young were born under observation as long ago as 1844, and exhibited as spirit specimens to the Belfast Society of Natural History. Nor have the early stages of the European Proteus been obtained. But, on the other hand, with respect to cave crustacea, Tellkampf, the original describer of the blind *Cambarus pellucidus* of the mammoth cave, stated that the eyes were larger in the young than in the adult (A. S. Packard, *Amer. Nat.* 1871), and Garman (*Bull. Mus. Comp. Zool* xvii. 1888-89) states that in very young specimens of *C. setosus*, the blind crayfish of the Missouri caves, "the eyes are more prominent, and appear to lack but the pigment." In another blind subterranean species, *Troglocaris Schmidtii*, occurring in Central Europe, Dr. Gustav Joseph found and demonstrated that the embryo in the egg was provided with eyes. (See Packard, "Cave Fauna of N. America," *Nat. Acad. Sci.* vol. iv. Mem. 1.)

Thus, although it is obvious enough that further investigation of the development of cave-animals is required, it cannot be said that it is altogether a "hitherto unattempted embryological research." A discussion of this kind ought not, however, to be a mere logomachia. My purpose is to show that cave-animals afford a particular case of the general problem how to reconcile the law of recapitulation with the theory that adaptations or degenerations are explained by the selection of congenital variations. J. T. CUNNINGHAM.

The Value of the Mechanical Equivalent of Heat.

IN NATURE for March 16 you published a summary of a communication which I had the honour to make to the Royal Society. My conclusion as to the value of the C.G.S. unit of heat was $4 \cdot 1940 \times 10^7$ ergs (see NATURE, p. 478), and I added the following comment: "If we express Rowland's result in terms of our thermal unit we exceed his value by 1 part in 930, and we exceed the mean value of Joule's (selected) determinations by one part in 350, ... if we attach equal value to *all* the results published by Joule his value *exceeds* ours by 1 part in 4280."

I have received so many communications with regard to this last statement, that you will perhaps permit me to answer my correspondents through your columns.

I thought it unnecessary in a short summary to point out that the value (in gravitation and Fahrenheit units) resulting from Joule's own experiments is *not* the usually accepted 772·55. To me it appears an extraordinary thing that 772 is to this day given in the text-books when, so far back as 1880, Rowland conclusively proved that the results obtained from Joule's experiments give a higher value (see Proceedings, American Academy, March 1880).

In 1879 Rowland forwarded to Joule a thermometer by Baudin, which had been directly compared with Rowland's air thermometer. Joule himself then made a careful comparison of his thermometer with the Baudin one, and communicated the results to Rowland. The complete table is given on p. 39 of the paper already referred to. In addition to the correction thus shown to be necessary, further corrections for the capacity for heat of the calorimeter and contents were included, and as the results were published in Joule's lifetime, there can be little doubt but that these corrections received his approval.

I give an example (from p. 44) of Rowland's corrections:—

Joule's value (by friction of water, in 1878) ...	772·7
Correction for thermometer	+3·2
,, capacity for heat	+ ·2
,, latitude (Baltimore)	+ ·9
,, vacuum	− ·9
Corrected value at Baltimore ...	776·1

It is evident that Rowland did not claim for his air thermometry an order of accuracy greater than $\pm \cdot 01°$. In the appendix to his paper (p. 197) he remarks that *if* a certain improvement (not then adopted by him) was made, "it is probable that an accuracy of ·01° C. could be obtained from the mean of two or three observations. I believe that my own thermometers scarcely differ much more than that from the absolute scale at any point up to 40° C."

A study of Rowland's methods, and of the tables given in his admirable paper, leads to the conclusion that it is possible that his thermometry is in error by 1 in 1000 over the range 15° to 25°, and such an error would suffice to bring together the results (both in the value of J and in the temperature coefficient of the specific heat of water) obtained by Rowland and myself. The error would, however, but slightly affect the correction of Joule's results.

If we attach arbitrary values to Joule's later experiments, the mean of the corrected values (by Rowland's thermometer) is 776·75 ($g = 32 \cdot 195$); and the mean of all his determinations by various methods is 779·17,[1] and we may regard the above as within 1 in 1000 of the value resulting from Joule's own work on this subject.

I trust that in future our engineers and text-book writers will (even if they ignore the work of later observers) do Joule the justice of discarding the traditional 772, and adopt a value more in harmony with the investigations of that great experimentalist. E. H. GRIFFITHS.

12, Parkside, Cambridge.

[1] In terms of a thermal unit at 15° C.

THE SENSITIVENESS OF THE EYE TO LIGHT AND COLOUR.[1]

THERE may be some here who have had the pleasure—or the pain—of rising very much betimes in a Swiss centre of mountaineering in order to gain some mountain peak before the sun has had power enough to render the intervening snow-fields soft, or perhaps dangerous. Those who have will recollect what were the sensations they experienced as they sallied out of the comfortable hotel, after endeavouring to swallow down breakfast at 2 a.m., into the darkness outside. Perhaps the night may have been moonless, or the sky slightly overcast, and the sole light which greeted them have been the nervous glimmer of the guides' lanterns. By this feeble light they may have picked their way over the stony path, and between the frequent stumbles over some half hidden piece of rock lying in the short grass they may have had time to look around and above them, and notice that the darkness of the night was alone broken by stars which gave a twinkle through a gap in the clouds, or if the sky were cloudless, every star would be seen to lie on a very slightly illuminated sky of transparent blackness. Although giant mountains may have been immediately in front of them, their outlines would be almost if not quite invisible. As time went on the sky would become a little brighter, and what is termed the *petit jour* would be known to be approaching. The outlines of the mountains beyond would become fairly visible, the tufts of grass and the flowers along the path would still be indistinguishable, and most things would be of a cold grey, absolutely without colour. The guide's red woollen scarf which he bound round his neck and mouth would be black as coal. But a little more light, and then some flowers amongst the grass would appear as a brighter grey, though the grass itself would still appear dark; but that red scarf would still be as black as a funeral garment. The mountains would have no colour. The sky would look leaden, and were it not for the stars above it might be a matter of guesswork whether it were not covered over with cloud.

More light still, and the sky would begin to blush in the part where the sun was going to rise, and the rest would appear as a blue-grey; the blue flowers will now be blue, and the white ones white; the violet or lavender coloured ones will still appear of no particular colour, and the grass will look a green grey, whilst the guide's neckgear will appear a dull brown.

The sun will be near rising, the white peaks beyond will appear tipped with rose; every colour will now be distinguished, though they would still be dull; and, finally, the daylight will come of its usual character, and the cold grey will give place to warmth of hue.

But there may be others who have never experienced this early rising, and prefer the comfort of an ordinary English tramp to that just described; but even then they may have felt something of the kind. In the soft autumn evening, when the sun has set, they may have wandered into the garden and noticed that flowers which in the daytime appear of gorgeous colourings—perhaps a mixture of red and blue—in the gloaming will be very different in aspect. The red flowers will appear dull and black; a red geranium, for instance, in very dull light, being a sable black, whilst the blue flowers will appear whitish-grey, and the brightest pale yellow flowers of the same tint; the grass will be grey, and the green of the trees the same nondescript colour. A similar kind of colouring will also be visible in moonlight when daylight has entirely disappeared, though the sky will have a transparent dark blue look about it, approaching to green. These sensations, or rather lack of sensations of light and colour, which as a rule attract very little attention, as they are common ones, are the subjects of my discourse to-night.

Experiments which can be shown to a large audience on this subject are naturally rather few in number, but I will try and show you one or two.

We are often told that the different stages of heat to which a body can be raised are black, red, yellow, and white heat, but I wish to show you that there is an intermediate stage between black and red heat, viz. a grey heat. An incandescent lamp surrounded by a tissue paper shade, has a current flowing through it, and in this absolutely dark room nothing is seen, for it is black hot. An increase of the current, however, shows the shade of a dim grey, whilst a further increase shows it as illuminated by a red, and then a yellow light. A bunch of flowers placed in the beam of the electric light shows every colour in perfection; the light is gradually dimmed down, and the reds disappear, whilst the blue colours remain and the green leaves become dark. These two experiments show that there is a colour, if grey may be called a colour, with which we have to reckon.

Now the question arises whether we can by any means ascertain at what stage a colour becomes of this grey hue, and at what stage of illumination the impression of mere light also disappears, and whether in any case the two disappear simultaneously.

As all colours in nature are mixed colours, it is at the outset useless to experiment with them in order to arrive at any definite conclusion, hence we are forced—and the forcing in this direction to the experimentalist is a very agreeable process—we are forced to come to the spectrum for information.

The apparatus on this table is one which I have before described in this theatre, and it is needless for me to describe it again. I can only say that it has in all colour investigations been of such service that any attempt on my part to do without it would have been most disadvantageous. The apparatus enables a patch of what is practically pure monochromatic light of any spectrum colour to be placed upon the screen at once, and an equally large patch of white light alongside it, by means of the beam reflected from the first surface of the first prism.

It should be pointed out that this beam of white light reflected from the first prism of the apparatus, having first passed through the collimator, must of necessity diminish with the intensity of the spectrum, when the collimator slit is closed.

Having got these patches, the next step is to so enfeeble the light that their colour and then their visible illumination disappear.

An experiment which well demonstrates loss of colour is made by throwing a feeble white light on one part of the screen, and then in succession patches of red, green, and violet alongside it. The luminosity of the coloured light gradually diminishes till all the colour disappears, the white patch being a comparison for the loss of colour.

If red, green, and violet patches be placed alongside each other, and they are bedimmed in brightness together, it will be noticed that the red disappears first, then the green, and then the violet; or I may take a red and green patch overlapping, which when mixed form orange, and extinguish the colour: the slit allowing red light to fall on the screen may be absolutely closed, and no alteration in the appearance of the patch is found to occur. This shows, I think, that when all colour is gone from a once brilliant colour, a sort of steel-grey remains behind, and that red fails to show any luminosity when the green still retains its colour.

The measurement of the extinction of colour from the different parts of the spectrum was made on these prin-

[1] A Lecture delivered at the Royal Institution of Great Britain by Captain W. de W. Abney, C.B., R.E., D.C.L., F.R.S.

ciples. A box, similar to Fig. 2, was prepared, but having two apertures, one at each side. Through one the coloured ray was reflected, and through the other a white

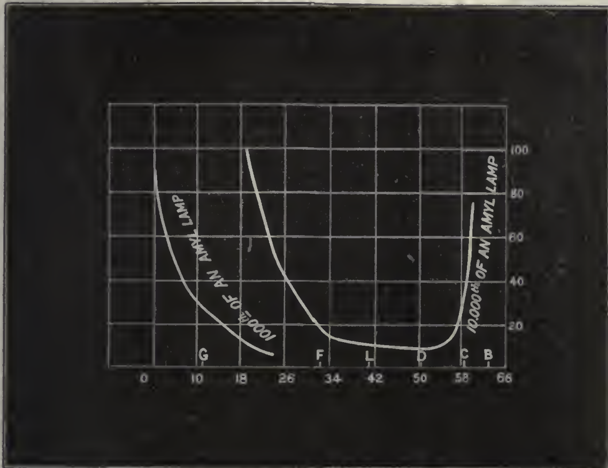


FIG. 1.—Extinction of Spectrum Colours.

beam of light to a white screen. Both beams were diminished, and when the white and coloured patches appeared the same hue, the amount of illumination was calculated. Fig. 1 shows graphically the reduction of illumination, when the D light of the spectrum is the same intensity as one amyl-acetate lamp at one foot from the screen. To measure the extinction of light, a box was made as in the diagram, closed at each end, but having two apertures as shown, Fig. 2:—E is a tube through which the eye looks at S, which is a black screen with a white spot upon it, and which can be illuminated by light coming through the diaphragm D first falling on a ground glass which closes the aperture, and reflected on to it by M a mirror.

The patch of light of any colour being thrown on D, rotating sectors, the apertures of which could be opened and closed at pleasure, were placed in the path of the beam, thus enabling the intensity of the patch to be diminished. D could be made of any desired aperture, and thus the illumination of the ground glass would be diminished at pleasure. After keeping the eye in darkness for some time, the eye was placed at E, when the white spot illuminated by the colour thrown on D was visible, and the sectors closed till the last scintilla of light was extinguished. This was repeated for rays at different parts of the spectrum, and the results are shown in Fig. 3 by the continuous curved lines. The diagram would have been too large had the same scale been adopted throughout for the ordinates; each curve is therefore made on a scale ten times that of its neighbour, counting from the centre.

In the diagram the sodium light of the spectrum before extinction was made of the luminosity of the amyl-acetate lamp (hereafter called AL), which is about ·8 of a standard candle, at 1 foot distance from the source. Before it ceased to cause an impression on the eye, the illumination had to be reduced to $\frac{350}{10{,}000{,}000}$ A L.

E light	to	$\frac{65}{10{,}000{,}000}$			Of its spectrum luminosity.
F light	,,	$\frac{150}{10{,}000{,}000}$	or	$\frac{15}{1{,}000{,}000}$	
G light	,,	$\frac{3000}{10{,}000{,}000}$	or	$\frac{3}{10{,}000}$	
C light	,,	$\frac{11{,}000}{10{,}000{,}000}$	or	$\frac{11}{10{,}000}$	
B light	,,	$\frac{70{,}000}{10{,}000{,}000}$	or	$\frac{7}{1000}$	

There was one objection which might have been offered to this method, and that was to the use of the rotating sectors, and perhaps to the ground glass. This objection was met by first of all reducing the light by means of a double reflection of the beam forming the patch from one or two plain glass mirrors, and also by using a plain glass mirror in the box instead of a silvered glass. By this plan the light falling on the first plain glass mirror was reduced, before it reached the end of the box, 1000 times; and again, by narrowing the slit of the collimator, and also the slit placed in the spectrum, another similar reduction would be effected. All rays thus enfeebled were within the range of extinction. It was found that neither ground glass nor rotating sectors

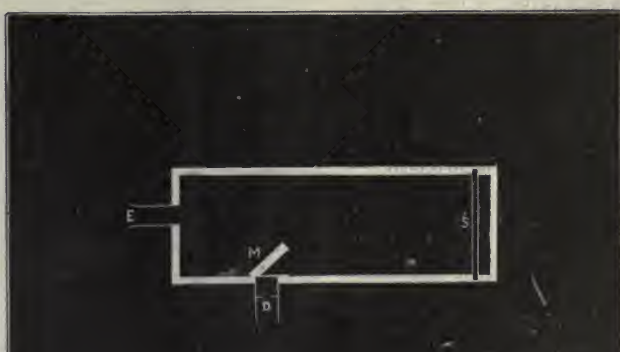


FIG. 2.—Extinction Box.

had any prejudicial effect, and therefore this extinction curve may be taken as correct.

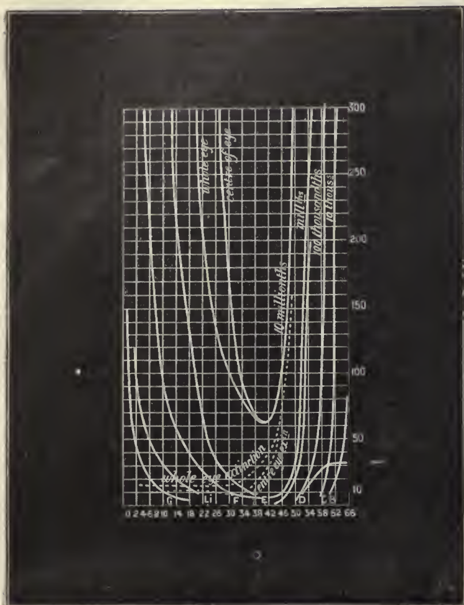


Fig. 3.—Extinction of the Spectrum.

In the curves there are two branches at the violet side, and this requires explanation. One shows the extinction when viewed by the most sensitive part of the eye, wherever that may be, and the other when the central portion of the eye was employed. The explanation of this difference in perception is chiefly as follows:—

In the eye we have a defect—at least we are apt to call it a defect, though no doubt Providence has made it for a purpose—in that there is a yellow spot which occupies some 6° to 8° of the very centre of the retina, and as it is on this central part that we receive any small image, it has a very important bearing on all colour experiments. The yellow spot absorbs the blue-green, blue, and violet rays, and exercises its strongest absorption towards the centre, though probably absent in the very centre, that is, in the "fovea centralis," and is less at the outer edges. That absorption of colour by the yellow spot takes place can be shown you in this way. Any colour in nature can be imitated by mixing a red, a green, and violet together, and with these I will make a match with white and then with brown, two very representative colours, if we may call them colours. Now if I, standing at this lecture table, match a white by mixing these three colours together, using a large patch, the image will fall on a part of the retina of considerably larger area than the yellow spot, and it will appear too green for those at a distance; but it is correct for myself. If I place a mirror at a distance, and make a match again by the reflected image, the match is complete for us all, as we all see it through the yellow absorbing medium. If I look at it direct from where I stand the match is much too pink. It may be asked why the comparison patches and the mixed colours do not always match since both images are received on the same part of the retina. The reason is that the green I have selected for mixture is in the part of the spectrum where great absorption takes place, whilst the comparison white contains the green of the whole spectrum, some parts of which are much less absorbed than others. I may remark that just outside the yellow spot the eye is less sensitive to the red than is the centre, and this is one additional cause of the difference. See Fig. 5.

More on this subject I have not time to say on this occasion, but it will be seen that the extinction of light for the centre and the outside of the eye differs on account of this.

I must take you to a theory of colour vision which, though it may not be explanatory of everything, at all events explains most phenomena—that is, the Young-Helmholtz theory. The idea embodied in it is that we have three *sensations* stimulated in the eye, and that these three sensations give an impression of a red, a green, and a violet. These three *colours* I have said can be mixed to match any other colour, or, in other words, the three sensations are excited in different degrees, in order to produce the sensation of the intermediate spectrum colours, and those of nature as well.

The diagram Fig. 4 shows the three sensations as derived from colour equations made by Kœnig. It will be seen that there are three complete colour sensations, all of which are present in the normal eye. I would ask you to note that at each end of the spectrum only one sensation is present, viz. at the red end of the spectrum, the red sensation, and at the violet end the violet.

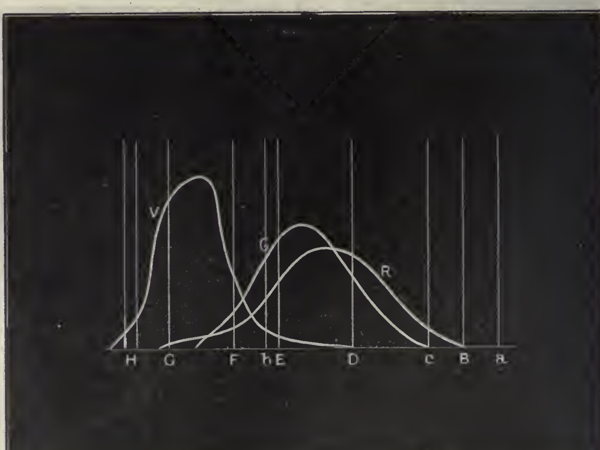


Fig. 4.—Colour Sensations.

This is a matter of some importance, as we shall now see.

It will be recollected that in making the extinctions, the D light of the spectrum was made equal to one amyl-acetate lamp, and the other rays had the relative luminosity to it, which they had in the spectrum before they were extinguished. The luminosity curve of the spectrum is shown in Fig. 5.

Suppose we make all the luminosities of the different rays equal to one A L., we should not get the same extinction value, as shown in the continuous lines in Fig. 3. The violet would have to be much more reduced, but by multiplying the extinction by the luminosity we should get the curve of reduction for equal luminosities, and we get the dotted curves in Fig. 3.

It will be seen that it is the violet under such circumstances that would be the last to be extinguished, and that all the rays at the violet end of the spectrum would be extinguished simultaneously, as would also those at the extreme red. This looks like a confirmation of the Young-Helmholtz theory which I have briefly explained, for we cannot imagine that it can be anything but a single sensation which fails to be excited.

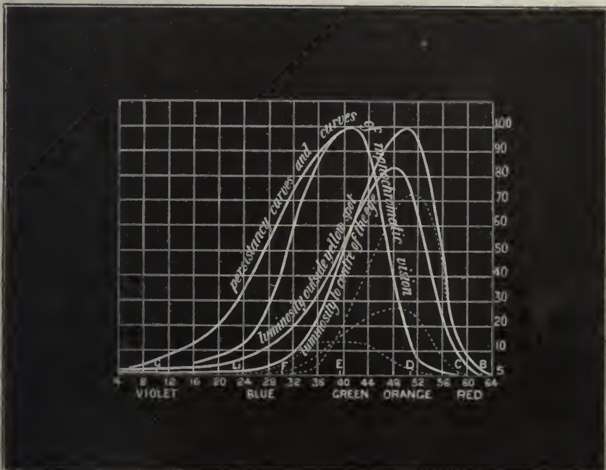


Fig. 5.

The violet is extinguished when it is $\frac{15}{10{,}000{,}000}$ A L, that is, a screen placed 817 feet away and illuminated by an A L violet lamp would be invisible. The blue-green (F) light when it is $\frac{17}{10 \text{ millionths}}$ or 770 feet away. The green (E) light $\frac{35}{10 \text{ millionths}}$ or 550 feet away. The orange (D) light is extinguished as before at $\frac{350}{10 \text{ millionths}}$ or 180 feet away, whilst the red (C) light has only to be reduced to $\frac{2200}{10 \text{ millionths}}$ or an A L lamp radiating C light would have to be placed only 67 feet away, whilst the radiation for an A L of the colour of the B light of the spectrum would have to be diminished to but $\frac{2600}{10 \text{ millionths}}$ or the screen would have to be placed 60 feet away.

It is therefore apparent that with equal luminosities the violet requires about 175 times more reduction to extinguish it than does the red, and probably about 25 times more than the green.

This being so, I think it will be pretty apparent that, at all events from the extreme violet to the Fraunhofer line D of the spectrum, the extinction is really the extinction of the violet sensation, a varying amount of which is excited by the different colours. If then we take the reciprocals of the numbers which give extinction of the spectrum, we ought to get the curve of the violet sensation on the Young-Helmholtz theory. For if one violet sensation has to be reduced to a certain degree before it is unperceived, and another has to be reduced to half that amount, it is evident that the violet sensation must be double in one case to what it is in the other; that is, the degrees of stimulation are expressed by the reciprocal of the reduction.

Such a curve is shown in Fig. 5 (in which also are drawn the curves of luminosity of the spectrum when viewed with the centre of the retina and outside the yellow spot). And it will be noticed that it is a mountain which reaches its maximum about E. Remember that the height of the curve signifies the amount of stimulation given to the violet sensatory apparatus by the particular ray indicated in the scale beneath.

Turning once more to Fig. 3, it will be noticed that if any one or two of the three sensations are absent, the persons so affected are, what is called, colour-blind. Thus if the red sensation is absent, they are red-blind; if the green, then green-blind; if the violet, then violet-blind; if both red and green sensations are absent, then the person would see every colour, including white, as violet. The results of the measurement of the luminosity of the spectrum by persons who have this last kind of monochromatic vision should be that they give a curve exactly or at all events very approximately, of the same form as the curve given by the reciprocals of the extinction curve obtained by the normal eye, as the violet sensation is that which is last stimulated.

It has been my good fortune to examine two such persons, and I find that this reasoning is correct, the two coinciding when the curves for the centre of the retina are employed.

Further, I examined a case of violet blindness, and measured the luminosity of the spectrum as apparent to him. Now if the Young-Helmholtz theory be correct, then in his case the violet sensation ought to be absent, and the difference between his luminosity and that of the normal eye ought to give the same curve as that of the violet sensation. This was found to be the case.

Again, the reciprocal of the extinction curves of the red-blind and green-blind ought to be the same as those of the normal eye, for the violet sensation must be present with them also. This was found to be so. We have still one more proof that the last sensation to disappear is the violet.

If we reduce the intensity of the spectrum till the green and red disappear to a normal eye, and measure the luminosity of the spectrum in this condition, we shall find that it also coincides with the persistency curve. On the screen we have a brilliant spectrum, but by closing the slit admitting the light and placing the rotating sectors in the spectrum and nearly closing the apertures, we can reduce it in intensity to any degree we like. The whole spectrum is now of one colour and indistinguishable in hue from a faint white patch thrown above it. If the luminosity of this colourless spectrum be measured we

shall get the result stated. The curve obtained in this way is in reality identical with the other curves. By these four methods then we arrive at the conclusion that the last colour to be extinguished is the sensation which when strong gives the sensation of violet, but which when feeble gives a blue-grey sensation.

One final experiment I may show you. It has been remarked that moonlight passing through painted glass windows is colourless on the grey stone floor of a cathedral or church.

We can imitate the painted glass and moonlight. Here is a diaper pattern of different coloured glasses, and by means of the electric light lantern we throw its coloured pattern on the screen. The strength of moonlight being known, we can reduce the intensity of the light of the lamp till it is of the same value. When this is done it will be seen that the pattern remains, but is now colourless, showing that the recorded observations are correct, and I think you are now in a position to account for the disappearance of the colour.

I have now carried you through a series of experiments which are difficult to carry out perfectly before an audience, but at any rate I think you will have seen enough to show you that the first sensation of light is what answers to the violet sensation when it is strong enough to give the sensation of colour. The other sensations seem to be engrafted on this one sensation, but in what manner it is somewhat difficult to imagine. Whether the primitive sensation of light was this and the others evolved, of course we cannot know. It appears probable that even in insect life this violet sensation is predominant, or at all events existent. Insects whose food is to be found in flowers seek it in the gloaming, when they are comparatively safe from attack. Prof. Huxley states that the greater number of wild flowers are certainly not red, but more or less of a blue colour. This means that the insect eye has to distinguish these flowers at dusk from the surrounding leaves, which are then of a dismal grey ; a blue flower would be visible to us whilst a red flower would be as black as night. That the insects single out these flowers seems to show that they participate in the same order of visual sensations. I venture to think, without adopting it in its entirety, that these results at all events give an additional probability as to the general correctness of the Young-Helmholtz theory of colour vision. Where the seat of colour sensation may be is not the point, it is only the question as to what the colour sensations make us feel which the physicist has to deal with. The simpler the theory, the more likely is it to be the true one, and certainly the Young-Helmholtz theory has the advantage over others of simplicity.

"*THE EPIGLOTTIS.*"[1]

FROM an anthropotomical point of view the epiglottis had for a long time been generally looked upon as a kind of sentinel for the protection of the upper air-passages, when Rückert's comparative anatomical observations showed that the human epiglottis greatly differed from that of mammals, in so far as its relations to the soft palate were entirely altered, and that its physiological conditions *pari passu* had undergone important modifications. The new points of view thus obtained induced Gegenbaur to study the comparative anatomy of the epiglottis and its relations to the larynx, and the present volume is the outcome of his investigations.

The inquiry being undertaken from a morphological point of view the author begins with a study of the different forms of the epiglottis or epiglottoid structures in low classes of animal life. He next discusses the mammalian epiglottis and its relations to the soft palate. The conclusions here arrived at, and which concern the act of deglutition in the lower classes of mammals, lead to a consideration of other organs of the oral cavity, and to an attempt at establishing a connection between these and the apparatus consisting of the epiglottis and soft palate. This in turn induces a minute investigation of the structure of the epiglottis, and of its relationship to the framework of the larynx and the general structure of the respiratory organs in the lowest forms of animal life. In the last chapter the author summarizes the results obtained by his comparative studies and throws out such suggestions concerning the origin, development, and function of the epiglottis as would seem justified by his researches.

Brief as this survey of the course of Gegenbaur's essay necessarily has been, it will be sufficient to show that it is quite impossible to give in the space of a short review a detailed analysis of its contents. Conclusions derived from the synthetic conception of an enormous number of single observations, which extend over a large part of the entire animal kingdom, can only be properly appreciated by a study of the original, and this may be warmly recommended.

The final and most important conclusion arrived at by the author may be briefly summarized as follows :—

Whilst as high up in the scale as in the sauropsidæ, parts of two branchial arches only contribute towards forming the primary hyoid, three more arches are added in the mammals. Two of these growing together form the transition into the thyroid, which becomes intimately connected with the larynx.

The mammalian larynx, however, has received a further addition, viz. the epiglottis, the cartilage of which can only be looked upon as the further development of the fourth branchial arch, which in fishes still serves its primitive function, and in the amphibia appears in a rudimentary form. The exact manner in which this rudiment passes over into the supporting organ of the epiglottis in mammals is, on the whole, still obscure. So much, however, is certain, that the cartilage of the epiglottis is not a product of mucous membrane, but a genuine part of the skeleton, and that it communicates its supporting function to the whole of the epiglottis, which serves as well the purpose of keeping the air-passages open as of protecting the vestibule of the larynx.

From this final conclusion it will be seen that, according to Gegenbaur, the *rôle* of the epiglottis in its highest development is purely a respiratory and protective one.

Pathological observation in man does not admit of these functions of the part being looked upon in any way as indispensable for the existence of the individual. Total loss of the epiglottis has often been observed in various diseases, without the patients either suffering from dyspnœa or from increased liability to the entrance of foreign bodies into the lower air-passages, the *constrictor vestibuli laryngis* (Luschka) in such cases vicariously taking its function. The supposed phonatory *rôle* of the epiglottis, upon which much stress is laid by some eminent singing masters (*e.g.* Stockhausen), inasmuch as they maintain that it influences, according to its more erect or more horizontal position, the "timbre" of the singing voice, is not even mentioned in Gegenbaur's essay. Thus many points connected with this subject still demand elucidation. Still it is impossible to withhold the expression of admiration and of gratitude to the author of the present work for his patient and extensive researches in a very obscure field of comparative anatomy.

[1] "Die Epiglottis," Vergleichend anatomische Studie, by Carl Gegenbaur, with two plates, &c. (Leipzig: Wilh. Engelmann, 1892.)

NOTES.

ON Saturday the British Eclipse Expedition to West Africa arrived safely at Bathurst. The *Alecto* was there, ready to convey the party up the Salum River to the selected site.

On Tuesday next, April 11, Mr. J. Macdonell will begin at the Royal Institution a course of three lectures on symbolism in ceremonies, customs, and art; on Thursday, April 13, Prof. Dewar will begin a course of five lectures on the atmosphere; and on Saturday, April 15, Mr. James Swinburne will begin a course of three lectures on some applications of electricity to chemistry. The Friday evening meetings will be resumed on April 14, when Sir William H. Flower will deliver a discourse on seals.

The Academy of Sciences in Turin announces that the ninth Bressa prize of 10,416 francs, for which all men of science and inventors of all nations are free to compete, is now offered (from January 1, 1891, to December 31, 1894). The prize will be given to whoever, in the judgment of the Academy, shall have, within the period indicated, made the most important and useful discovery, or shall have published the most profound work in the domain of the physical and experimental sciences, natural history, pure and applied mathematics, chemistry, physiology and pathology, geology, history, geography, and statistics. Any one wishing to compete must send his printed work (manuscripts are not accepted) to the President of the Academy. Unsuccessful works are returned, if it be desired.

At the meeting of the Chemical Section of the Franklin Institute, on February 21, a resolution was passed to the effect that the members had heard with deep regret of the death of their distinguished fellow-member, Dr. F. A. Genth, whose services as an investigator had "added lustre to American science." A committee was appointed to prepare a suitable memoir of Dr. Genth for publication in the proceedings of the Section.

Arrangements have been made for another series of summer excursions by the London Geological Field Class. The object of these excursions, which are planned by Prof. H. G. Seeley, F.R.S., is the study of the physical geography and geology of the Thames Basin. The first excursion will take place on April 29, when the students will go from Edenbridge to Westerham by Toys Hill. Each excursion will be under Prof. Seeley's personal direction.

A scheme for the organisation of the proposed University for London was adopted at a general meeting of the Association for Promoting a Professorial University for London on March 23, and has been submitted to the University Commissioners. It is printed in the *Times* of April 3.

The Scottish Technical Education Committee—appointed more than a year ago at a conference held in Edinburgh—has issued a report, from which it seems that Scotland has still a great deal to do before she can be said to possess a satisfactory system of technical instruction. At a recent meeting the Committee passed the following resolution:—"That, in the opinion of the meeting, it is desirable that the whole subject of higher and technical education should be dealt with in a comprehensive measure, and that the opportunity be not lost when the provision for secondary education is being inquired into in all parts of Scotland, to formulate a scheme for organising education beyond the elementary, and reducing in some degree the complications now existing, and the waste resulting from the various authorities that now have a connection with various parts of the educational system of Scotland, and that the chairman (Lord Elgin) be requested to take the necessary steps to bring the subject under the attention of the Government." At the same meeting the future action of the Committee was under consideration. It was felt that in present circumstances it would be very desirable to continue its existence if possible in some more definite shape, and a sub-committee was instructed to inquire under what conditions it might be brought into connection with the National Association for the promotion of secondary and technical education, and, if the sub-committee thought fit, to submit a form of constitution to the next meeting.

Shortly after eight o'clock on the morning of April 1 a severe earthquake shock was felt at Catania, and other places at the foot of Mount Etna. It was more especially pronounced at Nicolosi and Zaffarana-Etnea, where the population fled from their houses into the fields.

The weather continued exceptionally fine over England during the whole of last week, and in Scotland and Ireland the weather was generally fair, although slight rain occurred at times in a few places. The first few days of the period were the warmest experienced as yet this season, and 70° was reached in parts of England. In the suburbs of London the shade thermometer registered 68° or upwards on four consecutive days, and this is the average maximum temperature in June; while on Saturday, April 1, the thermometer reached 71° in the outskirts of the metropolis. The general indications on Saturday were more favourable to a change than for some time past, but the unsettled appearance suddenly gave way to an anticyclone, which reached our islands from the Atlantic, and the conditions again became settled, although the maximum day temperatures during the last few days of the period were generally somewhat lower under the influence of a gentle easterly breeze. The mean temperature for March was several degrees in excess of the average over the whole kingdom, and at Greenwich the excess amounted to 5°; while the mean of all the maximum day readings, which was 57°, was higher than in any previous March during the last half century. The total rainfall for March was also small over the whole country, and at Greenwich the aggregate amount was only 0·38 inches, which is the smallest fall in March since 1854. The *Weekly Weather Report* for the week ending April 1 shows that the duration of sunshine was 85 per cent. in the Channel Islands, 76 per cent. in the south of England, and 72 per cent. in the east of England.

We recently referred to the unsatisfactory condition of practical meteorology in Spain. The Royal Observatory at Madrid had for many years published results of observations taken at various stations in the peninsula, which furnish valuable materials for climatology; but daily telegraphic reports such as are issued in most other countries were necessary to complete the general synoptic view of weather conditions. We are glad to be able to report that this want has now been supplied. The first daily weather bulletin was recently issued, containing on one side a map showing isobars, wind direction and force, &c.; and on the other the actual telegraphic observations at a number of stations distributed over Spain and south-western Europe. The bulletin is published by the Central Meteorological Institute, which was established some little time since under the direction of Prof. A. Arcimis, to whose persistent efforts we are chiefly indebted for this new contribution to our knowledge of current weather.

The Meteorological Institutes of Hamburg and Copenhagen have issued their synoptic daily weather charts of the North Atlantic Ocean for the year ending November 1888. These charts contain the best materials for studying the various tracks and positions of the high and low pressure systems over the Atlantic; it is at once seen from them that in different parts of the ocean the storms take different routes, some follow a direct easterly track, others a more northerly course, while some form and others die out in mid-ocean. The great difficulty in storm prediction at present is to determine the routes that storms will take; a serious study of the conditions shown on such charts may eventually lead to the desired end, by enabling us to establish characteristic types of weather which accompany various depressions.

Mr. W. H. Greene and Mr. W. H. Wahl have elaborated a new process for the manufacture of manganese on the commercial scale. A paper by them on the subject was read before a recent meeting of the Chemical Section of the Franklin

Institute, and is printed in the Section's Proceedings for March.

A SIMPLE contrivance for determining the refractive index of a liquid without the use of a circular scale or a hollow glass prism, is described in *Wiedemann's Annalen* by Mr. H. Ruoss, of the Stuttgart Technical High School. The liquid is poured into a rectangular vessel, closed on one side by a plane-parallel glass plate. A small plane mirror is half immersed in the liquid, and mounted so that it can be placed exactly parallel to the plane-parallel side. A telescope is directed towards the mirror from outside, about 4 m. distant, its axis being normal to the glass side. To this telescope is attached at right angles a scale 3 m. long. On looking through the telescope the image of the scale in the mirror appears broken into two by the surface of the liquid, the lower image being formed by rays which have undergone refraction and reflection in the liquid. The divisions on the cross-wire measure the tangents of the angles of incidence and refraction respectively, which, since both the sets of rays after reflection are parallel, determine the refractive index of the liquid. A correction has to be applied for the thickness of the plate-glass, and it is best to make the angle of incidence as large as possible. Before taking the readings, the instrument should be adjusted by making the cross-wire coincide with its two reflections in the mirror and the plate, and placing the scale in a parallel and horizontal position with its reflected zero on the cross wire. With these adjustments and corrections the apparatus is capable of giving very accurate results. The angles can be measured to within 5″, and a large number of readings may be taken with different inclinations of the mirror. A set of five measurements for water in sodium light, for instance, gave a refractive index of 1·33276, which coincides with Walther's value to the fourth decimal place, and is subject to a probable error of 0·00003.

AT the magnetic observatory of Potsdam some interesting improvements have been made in registration of the needle's variations, a brief account of which is given by Herr Eschenhagen (*Met. Zeits.*). He uses a greater length of abscissæ than usual (20 mm. per hour), and obtains a fine curve by cutting off the border rays by means of a paper screen on the lens, by determining exactly the chemical focus, and by use of a very small mirror. The slit is 0·25 mm. In the case of great magnetic disturbances, trouble sometimes arises from the movable light point going beyond the recording surface, even where, as in Potsdam, this has a width of 190 mm. (7·6 inches), so that the most interesting parts of disturbances may be lost. An attempt was made to remedy this with prisms of a certain angle of refraction, but there are objections to this plan. A more simple and effective method was hit upon; the magnetic mirror is made in three parts, or facets, inclined to each other at an angle of 3°. It is enclosed in a bell-jar, in which the air is kept dry and free from sulphur vapour. The mirror gives three beams, of which usually only the middle one is concentrated in a fine light point on the drum. During a strong disturbance, and just before this light point leaves the drum, another point appears on the opposite side, which takes up and continues the record. These and other improvements will be described in detail ere long in publications of the Observatory.

ACCORDING to recent researches by M. T. J. van Beneden on the fossil Cetacea found in the regions of the Black Sea, the Caspian, and the Sea of Aral, the basin of the Black Sea contains all those forms which to-day characterise ocean fauna (Balænides, Ziphioides, Delphinides, and Sirenides); and taking also the region of rivers now flowing into that sea into account, it is probable that the whole of Central Europe at the end of the Miocene period was traversed by numerous arms of the sea, the Black Sea reaching to Vienna, Linz, and even to the Lake of Constance. Towards the end of the Pliocene, or the beginning of the quaternary period, owing to considerable depressions, the Straits of the Bosphorus were formed, and the water of the Mediterranean pressed into a basin formerly connected with the Arctic Sea. Thus the passage of a new fauna was made possible, which gradually, under favouring conditions, displaced the older. The Caspian was separated before the new forms had spread so far, and we find in it fifty-four species of fishes, which are neither in the Sea of Aral nor the Black Sea, and only six species which it has in common with those two others.

FROM recent researches on transference of material in plants (represented, *e.g.* by transference of starch in the potato), Herr Brasse is led to present the following view of what goes on: The assimilation of carbon in the sun's rays is manifested directly in deposition of starch in the chlorophyll grains. Through action of diastase in the leaves, and at a temperature lower than that of its formation, this starch is changed into reducing sugar, which spreads by diffusion from its place of formation into all the tissues of the plant. In certain parts, and especially in the tubers, the sugar is continuously transformed. The tubers, with regard to dissociation, act like the cold wall in vaporisation of a volatile liquid in an enclosed space. The sugar-content of all cells of the plant seeks to enter into equilibrium with that of the cells of the tubers, in which the content is less, because a change of sugar into starch takes place, and the coefficient of this change is here less than that of the converse change in the leaf, the temperature of the tuber being less. Owing to this inequality, there is a transference of starch from the leaf into the tuber, in which it passes through the intermediate stage of sugar. In a similar way Herr Brasse would explain the transference of nitrogenous and mineral plant materials, and their storage in special organs (*Comptes Rendus de la Société de Biologie*).

MR. E. LOMMEL has succeeded in fixing photographically the equipotential lines due to a current flowing through a conducting sheet. A current of 20 amperes was sent through sheets of copper 0·5 mm. thick and of various forms. The sheets were covered with sensitive paper strewn with iron filings, which arranged themselves along the lines of magnetic force due to the current, or, what amounts to the same thing, the lines of equal electrical potential along the conductors. The configurations thus obtained were fixed by holding a lighted match for a few seconds above the paper, yielding on development a beautiful representation of the flow through the current sheets. Two of these figures are reproduced in the last number of *Wiedemann's Annalen*. One of them represents the flow through a ring formed by two concentric circles, the current being conveyed by wires soldered to two diametrically opposite points. The other exhibits the equipotential lines in a rectangle with a hole in the middle and wires soldered to two opposite corners. A consideration of the various ways in which the presence of a strong magnetic field affects the configuration of the lines observed has led the author to a possible explanation of the "Hall effect." This phenomenon is only produced by magnetic lines of force running in a direction normal to the plate, or by the normal component of slanting lines. If in a rectangular current sheet made of diamagnetic material two points at equal potential, but on opposite edges of the sheet, be connected with a galvanometer, no current will be indicated until the sheet is brought into a strong magnetic field. According to Weber's theory of diamagnetism, currents are then generated in the molecules opposite in direction to the amperian currents. These molecular currents give rise to a resultant current round the edge of the sheet, strengthening the ordinary current on one side and weakening it on the other. This state of things

will be indicated by a deflection of the galvanometer needle and a distortion of the lines of flow, usually designated by "negative rotation." In the case of a paramagnetic body the rotation will be positive.

SEVERAL correspondents have written to us with regard to Mr. Hilderic Friend's letter on "Luminous Earthworms" (NATURE, March 16, p. 463). Several of them record observations which seem to them to confirm his statements. Mr. R. I. Pocock, of the British Museum (Natural History), points out, however, that the property of phosphorescence exists in a highly-developed state in certain terricolous, nocturnal animals, which, although both luminous and vermiform, are certainly neither glowworms, nor yet earthworms. "The power of producing adhesive phosphorescent matter from pores opening upon the ventral surface of the body has," says Mr. Pocock, "been recorded from different quarters of the globe, in the case of several genera of centipedes of the family *Geophilidæ*; and since no special affinity is traceable between all the forms that are known to be sometimes luminous, it is highly probable that the presence of appropriate glands for the secretion of the matter in question is, or has been in the past, characteristic of the whole group. About a dozen species of *Geophilidæ* occur in the south of England. All may be described as worm-like, and some of them are known to be phosphorescent. Curiously enough, the specimens that have been not uncommonly brought to the Natural History Museum as phosphorescent phenomena are referable to a species, *Linotænia crassipes*, which is the most earthworm-like of all, so far, at least, as colour is concerned. An example of this species was, I venture to suggest, the 'luminous earthworm' with the story of which Mr. Friend opens his account of the subject. This centipede is about one or two inches in length; and, although it is impossible quite to acquiesce in the statement that it is 'worm-like in all respects,' nevertheless I think it more than probable that a lady, finding one in the dusk of evening, when it could be but dimly seen, would summarily describe her idea of its appearance by some such expression as that used."

MR. J. E. HARTING, writing in the April number of the *Zoologist*, says that during a recent visit to Greece he lost no opportunity of interrogating the natives as to the birds and beasts to be met with, and was everywhere struck with the ignorance displayed on this subject, and the general indifference which prevailed respecting it. It was not until he reached the great plain of Larissa, where a plague of field voles has been for some time manifest, that he encountered those who could impart some information on at least one small indigenous mammal, namely, that which was causing such mischief and pecuniary loss to the resident land-owners. That it was a vole (*Arvicola*) of some sort was certain; but as to the precise species some difference of opinion had been expressed. Mr. Harting gives much very interesting information as to the animal's habits.

A PAPER on the foundations of the two river piers of the Tower Bridge, by Mr. G. E. W. Cruttwell, was read at the last meeting of the Institution of Civil Engineers before Easter. It was stated that the materials in the two piers, from foundation line up to a level of four feet above Trinity high-water (a height of 60 feet), consisted of 25,220 cubic yards of cement concrete, 22,400 cubic yards of brick-work in cement, and 3340 cubic yards of Cornish granite; making a total of 50,960 cubic yards.

THE Agricultural Research Association for the north-eastern counties of Scotland has issued its report for 1892. A general outline of some of the past year's results is presented, and this is followed by a record of observations, by Mr. Thomas Jamieson, relating especially to grass and clover roots.

MESSRS. E. AND F. N. SPON have issued a convenient little volume of waistcoat-pocket size, containing electrical tables and memoranda, by Prof. Silvanus P. Thompson and Eustace Thomas. The type is small but clear, and there are some illustrations.

MESSRS. CROSBY LOCKWOOD AND SON will publish in a few days a new work by Mr. J. D. Kendall, of Whitehaven, on "The Iron Ores of Great Britain and Ireland," giving an account of our present knowledge of the origin and occurrence of such ores, and the means of reaching and working them. Some of the more important iron ores of Spain are also noticed in the volume.

DR. E. SYMES THOMPSON will deliver lectures on the nose and mouth at Gresham College on April 11, 12, 13, and 14, at six o'clock.

UNTIL comparatively recently bacteriologists have regarded the macroscopic appearances to which organisms give rise when grown on potatoes as affording valuable assistance in distinguishing between otherwise very similar microbes. One notable instance of this is the alleged different behaviour of the typhoid bacillus and the closely allied *B. coli communis* when inoculated respectively on to potatoes. But more recent research has shown that as a diagnostic agent the potato is extremely untrustworthy, and this has moreover been conclusively demonstrated in the case of just these two organisms. Further evidence on this subject has lately been brought forward by Krannhals, "Zur Kenntniss des Wachsthums der Komma bacillen auf Kartoffeln" (*Centralblatt für Bakteriologie*, vol. xiii. p. 33), and the results he has obtained in the case of the cholera organism are very instructive. When cholera declared itself at Riga last August, Krannhals, as Prosector and Bacteriologist at the city infirmary, was deputed to demonstrate officially to the city medical authorities that it really was cholera which had broken out. The culture tests employed exhibited all the typical appearances associated with the cholera organism with the exception of its development on potatoes, upon which it obstinately refused to grow. Suspecting that this might be due to the acidity of the potatoes, slices were prepared and artificially rendered alkaline. On these the bacillus grew abundantly and moreover at from 16°–19° C., whereas it has hitherto been stated to be capable of only developing on this medium at from 30°–40° C. On the acid slices the same negative results were obtained as in all the previous experiments. In consequence of this discovery Krannhals conducted a large number of investigations on the behaviour of the cholera bacillus on acid and alkaline slices of potatoes respectively, and whereas he never failed to obtain vigorous growths on the latter even at the low temperature, he was only in very few instances (4 out of 136 experiments) able to induce its development on non-alkalised slices. But on testing those acid slices on which growths had appeared, it was found that they exhibited a distinct alkaline reaction. This alkalinity, moreover, had nothing to do with the growth of the bacillus, for sterile slices prepared in the same manner were tested both immediately on preparation and after they had been preserved some days, and the same astonishing result was obtained, *i.e.* that the slices of potato originally acid had during keeping become alkaline. Krannhals is led to suggest that in reality the cholera organism is incapable of growing on acid potatoes and that in those cases where it is stated to have developed on such, the medium unknown to the investigator must have, as in his experiments, changed from acid to alkaline. It is important that in future, therefore, the reaction of the potato should be noted both at the time of inoculation and later, when describing the growth of organisms on this medium.

Notes from the Marine Biological Station, Plymouth :—Last week's captures include the rare Nudibranch *Hero formosa*, specimens of the spiny shrimp (*Crangon spinosus*), and of the starfishes *Porania pulvillus* and *Henricia* (*Cribrella*) *sanguinolenta*. In the floating fauna *Plutei*, large and small, have now quite taken the place of the *Auricularia* and *Bipinnaria* larvæ, which were so plentiful a few weeks ago. *Arachnactis* is still obtainable. The unmodified ephyræ of *Aurelia* are now very scarce : most of them are passing through various phases of their metamorphosis into the definitive medusa-form ; and, instead of being plentiful everywhere, are now restricted to special localities.

The additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus*, ♂) from India, presented by Mr. J. Pitcher ; a Bengalese Cat (*Felis bengalensis*) from Manilla, Philippine Islands, presented by Mr. D. M. Forbes, F.Z.S. ; three Peafowls (*Pavo cristatus*, ♂ ♀ ♀) from India, presented by Mr. T. Guy Paget ; a Leadbeater's Cockatoo (*Cacatua leadbeateri*) from Australia, presented by Mrs. W. Everett Smith ; five Black-headed Gulls (*Larus ridibundus*), a Common Gull (*Larus canus*) European, presented by the Rev. E. M. Mitchell ; three Rhomb-marked Snakes (*Psammophylax rhombeatus*), a Hoary Snake (*Coronella cana*) from South Africa, presented by Messrs. H. M. and C. Beddington ; three Spring boks (*Gazella euchore*, ♂ ♀ ♀) from South Africa, a Raccoon (*Procyon lotor*) from North America, a Green Monkey (*Cercopithecus callitrichus*) from West Africa, deposited ; two silver-backed Foxes (*Canis chama*), a Cape Bucephalus (*Bucephalus capensis*) from South Africa, purchased ; a Short Death Adder (*Hoplocephalus curtus*) from Australia, received in exchange ; four Great Cyclodus (*Cyclodus gigas*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

Comet Swift (*a* 1892).—At the Boyden Station, Arequipa, Peru, during the visibility of this comet, all the photographic telescopes were turned towards it, with the result that a fine series of photographs were obtained. In the Bache 8-inch photographic doublet, fifty-six pictures (20 millimetres to the degree) were taken, sixteen of which "are of the first quality" ; in the 2·5-inch photographic doublet (3·8 millimetres to the degree) twelve satisfactory plates were taken, while in the 13-inch refractor and 20-inch reflector several additional negatives were collected. An examination of the negatives, especially of those belonging to the first series, indicated two important facts, as Mr. A. E. Douglass (*Astronomy and Astrophysics* for March) informs us. (1) That the tail of the comet was composed of luminous masses receding from the head at a measurable rate, and (2) that the form of the tail depended largely on some varying force acting at the head. The former of these results was deduced from measurements of the distance of prominent points (8 points were here used) from the nucleus, and the acceleration he obtained amounted to 477,000 miles per day. In discussing the second fundamental results, he deals with the general characteristics of the tail and the special phenomena within half a degree of the head, separately. The tail he describes as "a bundle of slightly divergent straight streamers, branching from each other and joined to the head by one, two, or three well-marked lines." At the southern part of the tail the photographs showed the appearance of a curious twisting effect, while a number of faint streamers, in many cases not joined to the main part of the tail, were also visible. The curve of the natural tangents of the position angles for the date on which they left the head, is, as plotted out by Mr. Douglass, quite irregular, and suggests "non-periodic outbursts from the head of the comet or variations in the repulsive force of the sun" ; where the tail swings to one side there are "large jets in the opposite direction as if the whole resulted from some increase in activity in the head." He suggests that this activity may be connected with solar disturbances, just as magnetic storms on the earth may be connected with certain classes of sunspots.

Paris Observatory in 1892.—From the annual report on the condition of the Paris Observatory during the year 1892, which was presented to the Council in January last by M. Tisserand, the Director, we gather the following brief notes :

Commencing with a short reference to the late Director, l'Amiral Mouchez, and to the great loss both to the Observatory itself and to astronomical science in general, M. Tisserand informs us that, at the suggestion of M. O. Struve, the presidency of the Comité permanent de la Carte du Ciel has passed to the present Director of the Paris Observatory. This choice has been received very favourably, and been confirmed by all the members of the committee. Let us here tender our congratulations to M. Tisserand, who, without doubt, will, in his capacity as president, bring such a grand work as nearly as possible to perfection. In fact, he has commenced by increasing the personnel du Bureau de Mesures des Clichés at the Observatory, and constructing a new machine for the measures, while he hopes soon to publish a fascicule of the *Bulletin de la Carte du Ciel*, which will contain the method of reducing the measures, and of the definite computations of the positions of the stars.

The large equatorial Coudé has this year been subjected to a minute study by M. Lœwy from the point of view of its optical qualities, and of the possibility of improving it still more. The experiments have as yet been restricted to the mounting of the mirror, and it seems that important results may soon be forthcoming. The spectroscopical department, under the direction of M. Deslandres, has, as we are informed, quite assumed a definite form since its foundation in 1890 ; the work done is tabulated under the three headings—sun, stars, and laboratory work. As we have previously referred in these columns to most of the work here accomplished, such as, for instance, the researches of the velocities of stars in the line of sight (250 stars will here be included), photographs of protuberances, faculæ, new hydrogen radiations, &c., further notice will be unnecessary. With the Equatorial de la Tour de l'Ouest, the programme of observations has been the same as in previous years, measures of the positions of comets, nebulæ, and double stars having been obtained. Among the observations here recorded as many as 136 were made of Comet Swift (1892), 41 of Comet Denning (1892), while 250 nebulæ and 120 double stars have been measured. All the above were made by M. Bigourdan. M. Faye also made 77 observations of comets. With the Cercle Méridien du Jardin under the special service of M. Lœwy, the total number of observations amounted to 16.686 ; 453 observations were made of the sun, moon, and planets. M. Paul and Prosper Henry have been occupied in obtaining clichés of the international chart and of the catalogue ; photographs have also been taken of the late nova in Auriga, Jupiter, and Comet Holmes. The Bureau des Mesures des Clichés du Catalogue, under the direction of Mdlle. Klumpke, has been very busy. At this part of the report a brief description of the measuring machine is given, and in a paragraph on "reflexions sur le catalogue et la durée de son exécution," we are told that, if simply the 1200 or 1400 clichés which are demanded for the work in each of the eighteen observations are obtained "on peut espérer d'y atteindre en cinq ou six ans au plus." For measuring the clichés with one machine, and two persons to observe and write the results, 130 clichés could be done in a year, but it would take about 10 years to measure the clichés attributed to one observatory, with one machine and two persons working incessantly. The report contains also all the meteorological work and that done with the minor instruments, concluding with the usual lists of personal publications, observatory publications, changes in the personnel, &c.

The Large Nebula near ξ Persei (N. G. C. 1499).—Dr. F. Scheiner, in *Astronomische Nachrichten* (No. 3157), describes briefly this great nebula near ξ Persei, several photographs of which he has been able to obtain. During November and December last, employing an objective of 4-inch aperture, he took fine photographs, with exposures varying from 1 to 6 hours. The longest exposed plates showed that the size of this nebula has been considerably under-rated, and that it comes nearly up to that of Orion and Andromeda. This nebula, it will be remembered, was discovered by Prof. Barnard with a 6-inch objective, and the position which he gave, 3 h. 54·0 m. R.A. + 36° 1′ Decl. (1855·0), referred to

the more northern part. Dr. Scheiner's photographs show that its extension southward is very considerable, but, owing to its dimness, was not seen by Prof. Barnard. The form of this nebula, a copy of which is given in this number, is inclined to be spirally, although not so apparent as that of Andromeda, and, curiously enough, it lacks a bright nucleus, as in the latter.

MINOR PLANETS.—The work of discovering minor planets seems, at the present time of the year, to be in a very flourishing condition, although rather restricted to two observers, according to the current number of *Astronomische Nachrichten* (No. 3157). Charlois with 10 and Wolf with 2, bringing the present notation up to 1893 x, is a good number for the first quarter of the year, and if this average be kept up we shall soon be driven to indulge in the Greek or German alphabet, or both.

GEOGRAPHICAL NOTES.

MR. JOHN BARTHOLOMEW, of Edinburgh, whose reputation as one of the foremost British map-makers is world-wide, died on March 30, at the age of 61. His career will be remembered as an epoch in the history of the perfecting and popularising of English maps. Trained in Edinburgh and afterwards under the late Dr. Petermann, in London, Mr. Bartholomew succeeded his father in a cartographical business in Edinburgh, which he steadily enlarged and improved, paying attention not only to excellence of mechanical production, but to the improvements of methods of representation. But the leading characteristic of Mr. Bartholomew's work was his conscientious endeavour to produce the most accurate topographical delineation. The general use of maps coloured orographically in this country is mainly due to the efforts of the Edinburgh Geographical Institute, of which he was the head. Mr. Bartholomew gradually withdrew from active work on account of failing health, and his son, Mr. J. G. Bartholomew, has taken his place in the Geographical Institute.

MR. THEODORE BENT (see p. 519) has been able to reach Aksum, where, however, he only remained for eight days, on account of tribal wars. The party had to retire abruptly because of a threatened fight, in which they were very nearly compelled to take sides, but fortunately the report of an advance of Italian troops to their relief solved the difficulty, and they reached the coast in safety. Despite the shortness of the working time, some good archæological results have been obtained.

THE March number of *Petermann's Mitteilungen* contains a valuable paper on North-west Patagonia by Dr. J. von Siemiradzki, with a map showing the results of his surveys and coloured to bring out the pastoral possibilities of the region. His route in 1891–92 led up the Rio Negro and Rio Limay to Lake Nahuel-Huapi and thence northward through the grassy valleys and bare slopes of the Cordillera to the Upper Biobio valley, whence the expedition passed to the coast of Chile.

THE Royal Geographical Society has given a grant to Dr. H. R. Mill to defray the expenses of a careful bathymetrical survey of some of the larger English lakes. The work, which will be carried out next summer, would be greatly facilitated if use could be had for a few days of a steam launch upon any of the lakes. Windermere, Coniston Water, and Wastwater will probably be sounded in the first place, as they are the most interesting from the limnological point of view.

A PAPER on the Geography and Social Conditions of the Iberian Peninsula read at the March meeting of the Berlin Geographical Society by Prof. Theobald Fischer is published in abstract in the April number of the *Geographical Journal*. The paradoxical character of the peninsula in the variety of its conditions has long been known. The great central plateau with its broken mountain border sloping steeply to the sea throws the bulk of the population towards the coast-line. In the border zone of the peninsula comprising 45 per cent. of its area, more than 66 per cent. of the inhabitants are settled. The only large city in the central plains is Madrid; all the rest of the plateau is occupied by wheat-growers and sheep-rearers; the mining, fruit-growing and industrial interests being all confined to the seaward slopes. There are few parts of Europe in which the physical conditions so plainly dominate the whole character of a country.

GRAPHICAL SOLUTIONS OF PROBLEMS IN NAVIGATION.

1. IF we suppose the two angles P, S of a spherical triangle SPZ to be together less than two right angles, a plane triangle $S_1P_1Z_1$ may clearly be drawn such that $P_1 = P$ and $S_1 = S$. The sides of the spherical triangle PS, PZ, SZ being respectively denoted by p, c, z, those of the plane triangle may be taken in the following ratios:—

$$P_1S_1 = \tan \tfrac{1}{2}p,$$
$$P_1Z_1 = \tfrac{1}{2} \tan \tfrac{1}{2}(c + z) + \tfrac{1}{2} \tan \tfrac{1}{2}(c - z),$$
$$S_1Z_1 = \tfrac{1}{2} \tan \tfrac{1}{2}(c + z) - \tfrac{1}{2} \tan \tfrac{1}{2}(c - z),$$

These results may be easily verified.

Hence $\quad S_1Z_1 + P_1Z_1 = \tan \tfrac{1}{2}(c + z),$

and $\quad P_1Z_1 - S_1Z_1 = \tan \tfrac{1}{2}(c - z).$

From these equations we infer that Z_1 is the intersection of an ellipse and hyperbola which have the same foci P_1 and S_1. Suppose now that the line S_1P_1 contains, say, 100 divisions, and that a system of ellipses, having S_1 and P_1 as foci, with major axes 101, 102, 103 . . . and a system of hyperbolas whose axes are 99, 98, 97 . . . are drawn on one side of S_1P_1; then, by finding m_1, m_2 from the equations

$$m_1 = 100 \tan \tfrac{1}{2}(c + z) \cot \tfrac{1}{2}p,$$
$$m_2 = 100 \tan \tfrac{1}{2}(c - z) \cot \tfrac{1}{2}p,$$

we should be able to localise the point m_1m_2 as coming between two successive ellipses and also between two consecutive hyperbolas in the diagram.

2. The usefulness of such a diagram lies in its application to problems in navigation. For p may be taken as the north polar distance of the sun, z the complement of his altitude, and c the colatitude of the place of observation. Having determined m_1, m_2 and thus localised Z_1 in the diagram, the angle $Z_1P_1S_1$ is the hour angle which may be suitably measured.

If we interchange p and c in the diagram, thus making P_1 and Z_1 the foci, the point to be localised is S_1 from the equations

$$n_1 = 100 \tan \tfrac{1}{2}(p + z) \cot \tfrac{1}{2}c,$$
$$n_2 = 100 \tan \tfrac{1}{2}(p - z) \cot \tfrac{1}{2}c.$$

The difficulties attending this mode of representation will present themselves in another form in §4. It is sufficient to notice here that this use of the diagram has the advantage of giving two useful angles—$S_1P_1Z_1$, the hour angle, and $S_1Z_1P_1$ the azimuth.

3. The merit of both these modes of representation consists in their being each a single diagram, applicable at any time of year, though in northern latitudes more favourable to accurate measures in summer than in winter. Their demerit consists in the preliminary calculations of m_1, m_2, or n_1, n_2. This, however, might be minimised by supplying, along with the diagram, tables of the values of m for two arguments θ and ϕ given by

$$m = 100 \tan \tfrac{1}{2}\theta \cot \tfrac{1}{2}\phi$$

The whole amount of preliminary calculation would then consist in adding and subtracting p and z, and looking out m_1 and m_2.

I shall now investigate the nature of a diagram which requires no preliminary calculation.

Returning to the spherical figure SPZ, let us suppose SP to be fixed while the sides PZ, SZ vary so that Z describes a curve on the sphere. The corresponding point Z_1 will describe a corresponding locus on the plane. For example, if L describes a small circle with P as centre, the locus of Z_1 will be given by

$$\tan c = \tan\{\tfrac{1}{2}(c + z) + \tfrac{1}{2}(c - z)\}$$
$$= \frac{P_1Z_1}{1 - P_1Z_1^2 + S_1Z_1^2}.$$

Now, if we draw a perpendicular Z_1N to the side P_1S_1 we shall have

$$P_1S_1^2 - S_1Z_1^2 = P_1N^2 - S_1N^2$$
$$= \tan \tfrac{1}{2}p(2P_1N - \tan \tfrac{1}{2}p);$$
$$\therefore\ P_1Z_1 = \tan c \tan \tfrac{1}{2}p(\operatorname{cosec} p - P_1N).$$

This shows that the curve described by Z_1 is a conic section of eccentricity $\tan c \tan \tfrac{1}{2}p$, with focus at P_1 and directrix perpendicular to P_1C_1 at a distance cosec p from P_1.

Similarly, the curves corresponding to small circles about S_1 are conics with a common directrix and with focus at S_1, their curvatures being turned the opposite way from those about P_1.

The lines whose focus is P_1 are curves of equal latitude, and those whose focus is S_1 are Sumner lines. Suppose systems of both kinds of lines to be drawn, the figure will be divided into small quadrilaterals, and the eye, aided by a scale with small divisions, would approximately determine the point within any quadrilateral at which the values of c and z are given, intermediate between those of the bounding sides. It is difficult to estimate the error to which this determination would be liable, but supposing the linear dimensions of a quadrilateral at a distance of 10 inches from P_1 were comparable with the tenth of an inch and that an error of one-hundreth of an inch were committed in the direction $\perp^r$ to P_1Z_1, this would mean an error of 3 or 4 minutes in the measured value of the hour angle. This error would be important, but not large enough to condemn the method, and the estimate shows that the scale of the diagram should be as large as is practicable.

If we confine the diagram to points in north latitudes c may be taken to range between 30° and 90°, though it would obviously be desirable also to draw a few lines for which c is $>90°$. The range of z may be taken between 10° and 80°. The distance between the foci is, as we have seen, $\tan \frac{1}{2} p$ and the distance between the directrices is readily proved to be $\cot \frac{1}{2} p$. The consideration which determines the scale on which the curves should be drawn is that the Sumner for which $z = 80°$ should appear in the diagram as far as it may be required.

The curves in each diagram are different from those in every other for different values of p; for although it might at first appear that since the distance from the focus to the directrix is the same for $180° - p$ as it is for p some saving would be effected, the indications of the same curves in the two cases are different, and the Sumners are placed differently in regard to the parallels of latitude. In the case of the sun a diagram for every ten minutes change in declination would probably be necessary, and this would mean an enormous amount of work. Diagrams for a few of the best stars could, however, be constructed on this principle and would be extremely useful.

It will have been noticed that the angle $Z_1S_1P_1$ is equal to the angle ZSP in the spherical figure, but the azimuth is not represented in the plane figure. The following properties of the plane curves may therefore be stated:—

(1) The angle at which S_1Z_1 cuts the sumner at Z_1 is equal to the angle at which P_1Z_1 cuts the parallel of latitude.

(2) If a tangent at Z_1 be drawn to either curve, say the sumner, to cut S_1P_1 in T and perpendiculars be drawn from T to Z_1P_1, Z_1S_1 meeting them in M and N, then

$$\cos(\text{azimuth}) = \mp \frac{TM}{TN}$$

according as T falls between S_1 and P_1 or not. From this result a graphical determination of the azimuth is easily obtained.

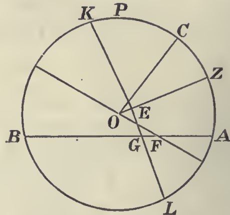
4. If we take Z_1P_1 for base line the curves to be drawn are curves of altitude and polar distance. This method of representation is tempting as the angles at P_1 and Z_1 are then the hour angle and azimuth. Moreover it would be a very convenient way of producing the diagrams to arrange them for consecutive values of the colatitude. Unfortunately there are serious objections. Suppose the common directrix of the polar distance lines cuts P_1Z_1 produced in X, then when the sun is in the southern hemisphere these lines are hyperbolas on the remote side of the directrix from P_1 and they diverge rapidly for consecutive values of $p > 90°$; so much so that, when the colatitude is between 30° and 40°, it is impossible to represent them on a scale which would be of any value. For places in the tropics there would not be the same objection, and diagrams drawn on this principle would be convenient in those regions.

There is another difficulty. In winter, in northern latitudes, the azimuth and hour angle may be together greater than two right angles or, what is equivalent, $p + z$ may be $>180°$. In that case the construction we are going upon fails, although it is possible to meet the difficulty.

The point is interesting, and admits of the following explanation:—In the figure P is the north pole, Z the place of observation, AB the diurnal path of the sun. If C be the middle point of PZ, then all points above the plane through the centre O perpendicular to OC may appear in the plane diagram supposed large enough. Again a plane KL perpendicular to OZ corresponding to $z = 80°$ limits the area in which observations may be taken. If, therefore, the sun were observed between F and G he would be out of the diagram, and this means that $p + z > 180°$.

The difficulty may be overcome by solving graphically another triangle $S_1{}^1P_1Z_1$ corresponding to S^1PZ in the spherical figure where S^1 is diametrically opposite to S. For, if $SZP + SPZ > 180°$ then $S^1PZ + S^1PZ < 180°$. Hence, if we interchange Z_1 and P_1 in the diagram and pick out the intersection of the curves $180° - z$ and $180° - p$ we shall thereby find graphically the supplements of the hour angle and azimuth.

5. To these modes of representation may be added stereographic projection on the plane of the equator which admits of lines of equal latitude and Sumner lines being represented by



systems of circles and of two angles of the spherical triangle being represented in the corresponding plane figure.

6. The object of all such methods is to facilitate the drawing of lines of position on a Mercator's chart, and as the hour angle must be determined with the greatest possible precision, the diagram should be on a large scale with hour angle lines drawn upon it at suitable intervals.

With this in mind the most practical of the foregoing methods would seem to be the first, viz. that in which there is a single diagram, cut into sections, not necessarily on the same scale, but large enough to admit of the hour angle lines and perhaps also azimuth lines being drawn upon it.

ANTHROPOLOGICAL USES OF THE CAMERA.

An interesting paper on the anthropological uses of the camera was lately read by Mr. E. F. im Thurn before the Anthropological Institute of Great Britain and Ireland, and is now reprinted in the Institute's "Journal."

Mr. im Thurn points out that primitive phases of life are fast fading from the world in this age of restless travel and exploration, and urges that it should be recognised as almost the duty of educated travellers in the less known parts of the world to put on permanent record, before it is too late, such of these phases as they may observe. It is certainly, however, he says, not a sufficiently recognised fact that such records, usually made in writing, might be infinitely helped out by the camera.

As illustrating the small use of the camera for this special purpose, Mr. im Thurn calls attention to the almost universal badness of illustrations of living primitive folk in books of anthropology and travel, when these illustrations are not merely what may be called physiological pictures. Of old the book illustrator, if, as was usual, he was not himself the traveller, drew as pictures of primitive folk, merely the men and women that surrounded him, drew figures of men and women of his own stage of civilisation, and merely added to these such salient features as he was able, from the traveller's tales, to fancy that his supposed primitive subjects had. So in 1599 the imaginative artist of Nuremberg who drew the pictures for the rare Latin abbreviation of Sir Walter Raleigh's "Discoverie of Guiana" gave to the world his impressions of the "Amazons," the "Headless Men," and the "Men who dwelt on trees" which are typical of the pictures of "savages" which adorn the travellers' books up to nearly the present century.

Mr. im Thurn refers also to the beautifully executed illustrations by Bartolozzi in Stedman's "Dutch Guiana," in which, in place of natives, are shown, with the necessary change of dress, simply Europeans of more than average beauty of form. There were doubtless exceptions to the misrepresentation of primitive folk, and the greatest of these exceptions known to Mr. im Thurn is the beautiful series of drawings by Catlin of North American Redmen. But Catlin enjoyed the unusual advantage not only of considerable technical skill as an artist,

but of living among the folk whom he drew and about whom he wrote. Even his drawings, valuable as they are, and artistically superior as they are, are far from having the value of the accuracy of photographs.

The modern anthropological illustrator does indeed generally draw from photographs; but almost always from photographs taken under non-natural conditions. Mr. im Thurn mentions as an example a picture of the Caribs of his own country of Guiana, which appears in one of the most valuable and accurate of recent anthropological books. This picture was the best attainable, and is evidently taken from a photograph; yet it gives no hint of what Caribs are like in their natural state. The explanation is easy. During Mr. im Thurn's many years' acquaintance with these Caribs, both in their native wilds and during their brief visits to the town, he has often been struck by the marvellous difference in their appearance when seen under these two differing conditions. It is true that in his natural surroundings the Carib is but very lightly clad, whereas, on the rare occasions when he enters the town he sometimes, but by no means always, puts on a fragmentary and incongruous piece or two of the cast-off clothing of white men, intending, by no means successfully, to adorn his person; but such separable accidents of rags by no means explain the full change in his appearance. Mr. im Thurn has seen the same men, in their distant homes on the mountainous savannahs between Guiana and the Brazils, though clothed with but a single strip of cloth, two or three inches wide and perhaps a yard in length, and either unadorned or adorned with but a scrap of red or white paint, look like what the novelists describe as well-groomed gentlemen. Yet the same individuals in Georgetown, without any added clothing or adornment, look the meanest and wretchedest folk imaginable. The sense of shyness and mean cringing fear which in the town doubtless drives out from them their innate sense of freedom and happy audacity, seems to find outward expression and completely to alter their bodily form. And it was quite evidently under some such depressing circumstances as these that the Redmen—who, by the way, were probably Ackawois and not "True Caribs"—who are shown in the illustration referred to, were photographed.

Just as the purely physiological photographs of the anthropometrists are merely pictures of lifeless bodies, so the ordinary photographs of uncharacteristically miserable natives seem to Mr. im Thurn to be comparable to the photographs which one occasionally sees of badly stuffed and distorted birds and animals.

Mr. im Thurn gives a clear and most attractive account of his own photographs of phases of primitive life in Guiana—photographs which, at the time of the reading of his paper, were shown on the screen. The following are some extracts from this part of the paper:—

Fifteen years ago I went out to Guiana as curator of the public museum, and in that capacity travelled much in the interior of that colony, only the seaboard of which was, and very little more now is, inhabited. Ten years ago I entered the service of the Government, and, as magistrate, took charge of a large district inhabited almost solely by Redmen. And I remained under those circumstances until, about two years ago, I was transferred to a neighbouring and still larger district of which it may be said that up to the time of my going there the white men who had visited it might be counted on the fingers of one hand. Throughout this time I have lived really among these pleasant red-skinned folk, now and again, for periods of greater or less duration, living not only among, but as they do; and throughout that period I have had none but Redmen as my servant friends. They have got used to me, and I have got used to them, and doubtless in this respect I have enjoyed greater advantages in the matter of gaining their confidence than the ordinary traveller, who merely passes through a country, could hope to enjoy. Some ten years ago, in a book on the "Indians of Guiana," I told all that I then knew about them. Though of course further experience has now taught me a good deal more about them, I must not here linger on anything that does not touch my special subject of to-night—my experiences as a photographer among them.

That to gain the confidence of uncivilised folk whom you wish to photograph is one of quite the most essential matters you will easily understand. The first time I tried to photograph a Redman was among the mangrove trees at the mouth of the Barima River. My red-skinned subject was carefully posed high up on a mangrove root. He sat quite still while I focussed and drew the shutter. Then, as I took off the cap, with a moan he fell backward off his perch on to the soft sand below him. Nor could he by any means be persuaded to prepare himself once more to face the unknown terrors of the camera. A very common thing to happen, and to foil the efforts of the photographer at the very moment when he has but to withdraw and to replace the cap, is for the timid subject suddenly to put up his hand to conceal his face, a proceeding most annoying to the photographer, but interesting to the anthropologist, as illustrating the very widespread dread of primitive folk of having their features put on paper, and being thus submitted spiritually to the power of any one possessing the picture.

With reference to my earlier remarks on the difficulty of discerning in the ordinary illustrations the real bodily appearance of uncivilised folk, photographs of the True Caribs of Guiana will be shown on the screen. And in so doing it may, without entering into elaborate detail, be once more pointed out that the red-skinned inhabitants of Guiana are distinguishable into three groups or branches (see "Among Indians of Guiana," p. 159, and "Proceedings of Royal Geographical Society," October, 1892). Though the actual pre-European history of these three is, unfortunately, still greatly a matter of conjecture, it is convenient to use such conjectures as seem most reasonable on this subject as a means of distinguishing the branches—that is to say, it is well to bear in mind that probably of the tribes at present in Guiana the Warraus, who inhabit the swamps about the mouth of the Orinoco, were the earliest occupiers, but that there is at present no evidence at all to show whence these people reached their present homes; that another of the branches, represented only by the Arawacks, who inhabit the whole sea-coast of that country with the exception of the more swampy lands of the Warraus, probably reached their present homes from the West Indian Islands long after the Warraus were already established in those parts; and that the third branch, usually called the Carib branch, and represented by the Ackawois, Macusis, Arecunas, and by the "True Caribs," came also from the Islands, but at various times, and made their way, in somewhat various directions, into the back lands of the country. The first set of pictures I am about to show you all are of this last or "True Carib" branch.

The first is of a middle-aged man who lives in the first falls of the Barima River. A single glance at it and a comparison of it with the ordinary, even the best book illustrations of Caribs, will at once serve to make plain the advantage of the photographic method used among the people in their own homes over any other method of showing what these primitive folk are really like. Before shooting the falls in their canoes the Redmen always carefully examine the state of the river to see which rocks are exposed, which lurk as hidden dangers beneath the surface in that particular state of the water; and it was while he was engaged in this cautious survey that this photograph of this Carib was taken. The next is of the same man taken under somewhat different circumstances. The hospitality of these persons is almost unbounded, and the etiquette of its observance is rigidly fixed. The master of the house, when expecting guests, grooms himself carefully and puts on his best dress and ornaments, these often, as in this case, consisting only of a narrow waistcloth by way of dress and of a necklace and armlets of white beads by way of ornament. Thus honouring the occasion to the best of his ability, he sits, somewhat stolidly, outside his house awaiting his guests, with whom, when they arrive, he will, without rising or in any other way testifying any interest, exchange one or two entirely conventional and monosyllabic sentences, dropping them out one by one at long intervals.

It is generally supposed that these red-skinned folk are undemonstrative in their bearing towards one another. But this really is only in the presence of strangers. When alone, or before others with whom they are familiar, their bearing toward each other is even caressing. Such a picture as this, of three Caribs standing with their arms round each other's necks, may often be seen.

The next picture, of a young Carib man, perhaps a little above the average in physique, is intended to show that these people, though not tall, are a fine people in the point of physical and muscular development.

Again, in the matter of facial expression, the ordinary conception of these people as dull and expressionless should give place to the truer idea that, when not made shy by the presence

of unaccustomed strangers, there is a great deal of life and even in some cases of beauty in their appearance. It is practically impossible for a stranger to see them in this their more pleasing and natural state, except when, as I now do in this picture of three Carib lads, they are taken under the most natural conditions, and distance and time being for the purpose annihilated, they are shown you in the most natural conditions but without their knowledge.

That it may not be said that in my anxiety to impress you with my own too favourable ideas of these red-skinned friends of mine, I have elected only to show you young fellows in their too brief prime, I next show you an old Carib. I must, however, admit that he is only old for a Redman. His age was probably about forty-five. But these happy childlike people lead but a short if a happy life, and are old at fifty, and rarely survive to sixty. . .

Another obvious, but insufficiently used, use of the camera for anthropological purposes would be for the better illustration of collections of objects of ethnological interest. Those who have tried know best the difficulty of showing these in an effective and interesting manner. Comparatively elaborate and correspondingly artistic objects made and used by a people who have made considerable progress without attaining what we are pleased to call civilisation, are easily shown in an attractive manner; but the simpler objects, illustrating the daily life of people in a much more primitive state of civilisation, are not so easily placed. The articles which constitute the dress and ornaments of a people which makes but little use of ornament and less of dress, are generally of so simple a nature that when stored in rows or, as I am afraid is sometimes the case, in heaps or even in bundles, in museum cases, they too often seem deficient in interest to the very curators of the museum, and are naturally much more so to the outside public. Yet these same things, very likely, to one who has seen them in actual use, seem, just because of their simplicity, more interesting than the elaborate dancing masks and such like. It has been suggested —possibly the suggestion has been carried into effect—to display these on lay figures; but when it is remembered how very few of these simple articles of dress or ornament are worn at any one time, it is obvious that for their proper display in the suggested manner the number of lay figures which would be required would, for reasons both of economy and of space, make the plan ineffective. A much more feasible plan would be to place by the side of each object, or group of objects displayed, a photograph of the object—preferably of the identical object. A few examples will better explain what I mean:—

The first is a photograph of a Partamona (Ackawoi) Redman in a curious dress made and worn for a special festival celebrated by those people and called Parasheera. The dress consists of three parts, which may be described as skirt, cloak, and mask, all made of the bright greenish-yellow, immature leaves of the Æta palm (*Mauritia flexuosa*). Probably there is not an example of this dress in any existing museum; for it is probable that no white man except myself has ever seen it, and I frankly confess that I was deterred, as has often been the case under similar circumstances, from bringing away an example of the dress by the consideration that when seen off the body of the wearer it would look like nothing in the world but a small bundle of withered palm leaves, and would to the uninitiated seem supremely uninteresting.

The next example I show you is a picture of a Macusi lad in full dancing dress. Those who are acquainted with the ordinary heaped curiosities of the average ethnological collection will perhaps recognise the typical head-dress of bright parrot and macaw feathers, the loose hanging ruff of alternate black curassow and white egret feathers, and the strip of waist-cloth upheld by a cotton belt, which constitutes the whole of this dress; and such persons will probably recognise that these articles seen, as in this photograph, *in situ*, acquire a new interest.

Again, one of the commonest articles from Guiana seen in museums is the necklace of peccary teeth, much affected by all the Carib tribes. But in now showing you one of the finest specimens of this ornament I have ever seen, it will probably gain very much in interest from the fact that I am able at the same time to throw on to the screen a picture of the actual necklace on the Macusi, named Lonk, from whose shoulders I acquired it. And it may in passing be of interest to add that these necklaces, in the manufacture of which only the tusk teeth of the peccary are used, so that in proportion to its size each represents a very large number of animals, are most highly valued as heirlooms, and as representing the accumulated prowess not only of the wearer for the time being, but also of his ancestors, for this property is handed down in the male line of descent, and is added to by each holder. . . .

In short, a good series of photographs showing each of the possessions of a primitive folk, and its use, would be far more instructive and far more interesting than any collection of the articles themselves. Or, if it is desired to illustrate not the possessions but the habits of such folk, the thing can be done in the same way. A few examples from a large series showing the games of these people will illustrate this.

Many of their games are dramatic representations of ordinary incidents in their work-a-day life. One represents their rare and eventful visits to the distant town. Of the many figures in this game one represents the fully-manned canoe in which they go on their journey down the big rivers of the country. All but two of the players, seated on the ground, the one behind the other, and each clasping the player in front of him, form a long line, which, by the action of the feet and thighs of its constituent members, drags itself slowly forward, the whole swaying from side to side. In this way—which must certainly involve a considerable amount of somewhat painful friction, considering the hardness of the stony ground traversed and the unprotectedness of the skins of the players—a very realistic representation of the forward rolling motion of a large and well-manned canoe, such as would be used on a real journey, is attained. And the illusion is assisted by the players' noisy imitation of the regular and most characteristic rhythmic beat of the paddles against the sides of the canoe, and of the shouts of the paddlers.

After several other figures, another comes, in which the players, all standing in line, each falls forward on his hands and feet, his thighs the highest part of him, so that the whole line of players, with their closely pressed bodies, forms a long tunnel, through which each player in turn has, as in a well-known figure in the old-fashioned dance of Sir Roger de Coverley, to pass, but by creeping. The journey, that is, is nearly over; and the home-comers, leaving the broad river up which they have come so far, have turned into the narrow creek or side stream densely roofed with low hanging trees, which leads directly to their homes; and under this natural tunnel the canoe has to force its way.

Other games to be seen among the Redmen of the borders of Guiana and Brazil are simple representations of the doings of animals. For instance, one represents an aguti in a pen and the attempts of a jaguar to get him out. The players form a ring, their arms round each other's necks. Inside this circle one of the players crouches, and represents an aguti—a small animal often kept in captivity by the Redmen—inside the pen. Outside the pen another player watches; it is the jaguar looking with hungry eyes on the aguti. He tries to get the aguti out between the bars of the pen, that is, between the legs of the ring of players. But the living pen whirls round and round, and it is no easy task for the jaguar to seize the aguti and drag it out.

Yet more curious is the whipping game of the Arawacks. It is played by any number of persons, but generally only by men and boys, for one, two, or three days and nights—as long, that is, as the supply of *paiwari*, the native beer, holds out. The players, with but brief intervals, range themselves in two lines opposite each other. Every now and then a pair of players, one from each line, separate from the rest. One of these puts forward his leg and stands firm; the other carefully measures the most effective distance with a powerful and special whip with which each player is provided, and then lashes with all his force the calf of the other. The crack is like a pistol shot, and the result is a gash across the skin of the patient's calf. Sometimes a second similar blow is given and borne. Then the position of the pair of players is reversed, and the flogged man flogs the other. Then the pair retire, drink good-temperedly together, and rejoin the line, to let another pair take their turn of activity, but presently, and again and again at intervals, to repeat their own activity.

It has been said that the most active players of this extraordinary game are the men and boys. But occasionally the women take a part also. And it is noteworthy that when this is the case a wooden figure of a bird, a heron, is substituted for each of the whips, and a gentle peck with this bird is substituted for the far more serious lash of the whip. I do not know that any equivalent example of the fact that the germ of the idea of courtesy to the weaker sex exists among people even in this stage of civilisation is on record.

SOCIETIES AND ACADEMIES.

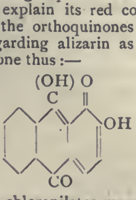
LONDON.

Chemical Society, March 2.—Dr. J. H. Gladstone, vice-president, in the chair. The following papers were read:—The magnetic rotation and refractive power of ethylene oxide, by W. H. Perkin. The magnetic rotation of ethylene oxide is remarkably low, and the refractive power is also below the calculated value.—The origin of colour (including fluorescence), vii. The phthaleins and fluoresceins, by H. E. Armstrong. The author has previously taken exception to the formulæ usually assigned to phenolphthalein and its congeners; the exhibition of colour by these substances could not be accounted for by the formulæ generally ascribed to them. The correctness of the author's views has now been demonstrated by Bernthsen and Friedländer independently. The former chemist has shown that the rhodamines afford true ethereal salts, proving that they form carboxy-compounds and not lactone derivatives. Bernthsen also points out that the characteristic development of colour observed on adding alkali to phenolphthalein is probably due to the hydrolysis and subsequent conversion of the colourless lactone derivative into a quinolic compound; the latter then suffers dehydration, affording a coloured quinonoid derivative:—

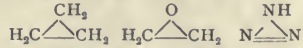
$$C_6H_4\left\{\begin{array}{l} CO \\ \quad\;\; \rangle O \\ C \;=\; (C_6H_4 \,.\, OH)_2 \end{array}\right. + H_2O = C_6H_4\left\{\begin{array}{l} CO_2H \\ C(OH)\,(C_6H_4 \,.\, OH)_2 \end{array}\right.$$

$$C_6H_4\left\{\begin{array}{l} CO_2H \\ C(OH)C_6H_4 \,.\, OH \\ | \\ C_6H_4 \,.\, OH \end{array}\right. = H_2O + C_6H_4\left\{\begin{array}{l} CO_2H \\ C \,.\, C_6H_4 \,.\, OH \\ \| \\ C_6H_4O \end{array}\right.$$

Friedländer also has lately shown that phenolphthalein and hydroxylamine interact in alkaline solution with formation of a hydroxime; this and other evidence has led him to the opinion that in their coloured state phenolphthalein and the allied phthaleins which behave similarly towards alkalis, are all quinonoid compounds. The fact that the rhodamines yield ethereal salts is also remarked in a patent specification by a German colour firm. The author considers the recognition of the quinonoid nature of the rhodamines and fluoresceins to be an important argument in favour of the views that fluorescence is a form of colour, and that all quinonoid derivatives would be visibly fluorescent were it not that the rays which cause the fluorescence sometimes become absorbed in the solution.—The origin of colour, viii. The limitation of colour to truly quinonoid compounds. Change of colour as indicative of change of structure, as in the case of alizarin, by H. E. Armstrong. A quinonoid compound may be defined as a *hexaphene, i.e.* an unsaturated cycloid composed of six "elements," of which two are $C\frown R''$ groups in either para- or ortho- positions. Coloured substances generally appear to fall within this definition; the few exceptions to the rule may be explained either by the author's view of isodynamic change or as resulting from the presence of traces of impurity. Some of the keto-chlorides prepared by Zincke possess an intense yellow colour, although containing the group—CCl_2—CO—; it is, however, not improbable that in such substances the group CCl_2 is the true equivalent of the $C\frown R''$ group. The usual constitution assigned to alizarin does not explain its red colour, red being the characteristic colour of the orthoquinones; the colour may be accounted for by regarding alizarin as an isodynamic form of dihydroxyanthraquinone thus:—



The red colour of the chloranilates may be explained in a somewhat similar manner.—Notes on optical properties as indicative of structure, by H. E. Armstrong. From a consideration of the refractive and dispersive powers of the metallic carbonyls, the author anticipates that quinonoid compounds generally will be found to possess specially high refractive powers. There are indeed experimental data supporting this view—anthracene, a hydrocarbon which is probably quinonoid in structure, having a high refractive power; further evidence is afforded by the specific refractions of the ortho- and para-nitranilines. The author then proceeds to discuss the orthodox formulæ for trimethylene, ethylene oxide, and diazoimide—



contrasting these substances with nitrous oxide; he contends that the above structural formulæ have no real justification, and that latent affinities may exist in these compounds just as in carbonic oxide. Thus nitrous oxide may be regarded as $< N - O - N >$, and diazoimide as $< N - \overset{\cdot\cdot}{N}H - N >$. The influence exerted by the ethenoid and benzenoid groups in organic substances upon their refractive and dispersive powers, is also considered.—The origin of colour, ix. Note on the appearance of colour in quinoline derivatives and of fluorescence in quinine, by H. E. Armstrong. From considerations based upon the previous notes, the author shows that any amido-derivative of quinoline might become quinonoid in structure, owing to a change from the centric to an ethenoid form, and would hence be coloured. Similarly, an ethenoid form of naphthalene would be quinonoid; it is therefore possible that the fluorescence exhibited by many derivatives of this hydrocarbon is characteristic of the pure substances, and does not always originate in impurities.—The ethereal salts of glyceric acid, active and inactive, by P. Frankland and J. MacGregor. The authors have prepared and characterised a number of ethereal salts of inactive and lævo-glyceric acid; they point out regularities between the rotatory powers of the active salts of a somewhat similar nature to those observed amongst the ethereal salts of tartaric acid.—Formation of the ketone 2 : 6-dimethyl-1-ketohexaphane, by F. S. Kipping. On distilling the calcium salt of dimethylpimelic acid with soda lime, an oil is obtained which contains a ketone of the composition $C_8H_{14}O$. This ketone is apparently a dimethylketohexamethylene; it is doubtless a homologue of the ketone recently prepared by von Baeyer by distilling calcium pimelate with soda lime.—Note on the interactions of alkali-metal haloids and lead haloids, and of alkali-metal haloids and bismuth haloids, by Eleanor Field. By boiling potassium or ammonium iodide with lead haloids in aqueous solutions, double compounds are obtained, whose composition depends upon the proportions in which the constituents are used. Salts of the compositions, $3PbI_2 4KI$, $3PbI_2 4NH_4I$, $PbI_2 3PbCl_2$, $PbI_2 5PbCl_2$, and $PbI_2 2PbBr_2$, are described. The interactions of haloid salts of the alkali metals with bismuth haloids lead to the formation of compounds having the following compositions—$BiBrCl_4K_2$, $BiClBr_4K_2$, and $BiCl_3Br_3(NH_4)_3$. The composition of the products obtained depends, not only on the proportions in which the reacting salts are employed, but also on the nature of the halogens and the metals.—An isomeric form of benzylphenylbenzylthiourea by A. E. Dixon. Phenylthiocarbimide and dibenzylamine interact to form the compound $PhN : C(SH) \,.\, N(C_7H_7)_2$, isomeric with the thiourea $C_7H_7N : C(SH) \,.\, NPh \,.\, C_7H_7$, melting at 103°, previously obtained by the author from benzylthiocarbimide and benzylaniline; the new substance melts at 145–146°.—A new atomic diagram and periodic table of the elements, by R. M. Deeley. The author constructs a new atomic diagram of the elements by plotting "volume heats" against "volume atoms." The volume heats are the products of the specific heats and densities, whilst the volume atoms are obtained by dividing relative density by atomic weight.

PARIS.

Academy of Sciences, March 27.—M. Lœwy in the chair.—The two candidates selected as competitors for the place of *Astronome Titulaire* at the Paris Observatory were: In the first place, M. Prosper Henry; in the second, M. Paul Henry.—On the construction of the chart of the heavens, and the determination of the co-ordinates of the centres of the negatives, by M. Lœwy.—On the organic substances constituting vegetable soil, by MM. Berthélot and André. "Humus" may be defined as that portion of the remains of vegetation which resists the action of the air and lower organisms, and remains as an insoluble residue in the soil, supplying the roots of the higher plants with nitrogen, sulphur, phosphorus, alkalies, &c. One specimen of earth freed from all visible plant remains, cellulose, and carbohydrates, taken from the experimental soil of the Vegetable Chemistry station at Meudon, contained 19·1 parts of organic carbon, 1·5 of hydrogen, 1·7 of nitrogen, 11·9 of organic oxygen, total 34·2 parts of organic matter. Some of

the principles could be isolated by dissolving them in alkalies, and reprecipitating by acids. These were found to contain 55·2 per cent. of carbon, 6·8 of hydrogen, 3·0 of nitrogen, 35·0 of oxygen, 3·5 of ashes. A repeated treatment with hydrofluoric and hydrochloric acids left in one instance 1·4 per cent. of insoluble matter of a constitution similar to the preceding. This insoluble matter acted upon solutions of potassium salts in much the same manner as artificial humic acid obtained from sugar. It forms potassium compounds which are capable of resisting even prolonged washing by rainwater. This explains the "absorbing" action of the soil upon the alkalies, and especially upon potash.—On the interference fringes of grating spectra on gelatine, by M. A. Crova.—Researches on samarium, by M. Lecoq de Boisbaudran.—Remarks on the native iron of Ovifak and the bitumen of the crystallised rocks of Sweden, by M. Nordenskiöld. Among the blocks of native iron brought from Ovifak in 1870 there was one of about 40 kgr. which it was impossible to saw or to cut. It is now supposed that this is due to black diamonds disseminated through the iron. Considerable masses of bitumen are found in the crystalline rocks of Sweden, notably near Norberg and Dannemora. One of the two kinds found gives a large number of distillation products and leaves hardly any ashes. The other resembles anthracite. It yields little on distillation, and leaves much residue on combustion. This residue contains, besides silica, iron, lime, magnesia, &c., some oxide of nickel, uranium (3 per cent.), cerium, and yttrium, the three last in the form of carbon compounds resembling nickel carbonyl. These also occur in carbon forming large nodules in the oldest sedimentary strata of Sweden, the alum schists.—Observations of small planets made at the Toulouse Observatory, by M. B. Baillaud.—The Bielids, by P. François Denza.—On orthogonal correspondance of elements, byM. Alphonse Demoulin.—On the possibility of defining a function by an entire divergent series, by M. H. Padé.—A new sclerometer, by M. Paul Jannettaz.—On the indications of water-level in boilers by a glass tube, and their influence upon explosions, by M. Hervier.—On initial capacities of polarisation, by M. E. Bouty. The electricity absorbed in virtue of capacity of initial polarisation is entirely recoverable, on the condition of employing for the discharge an external circuit of negligible resistance.—On the distillation of mixtures of water and alcohol, by M. E. Sorel.—A general method for the calculation of atomic weights according to the data of chemical analysis, by M. G. Hinrichs.—On the formation of gallanilide, and on its triacetyl and tribenzoyl derivatives, by M. P. Cazeneuve —On the lakes of Sept-Laux (Isère) and La Girotte (Savoie), by M. A. Delebecque.—On a means of preserving beetroot plants and economic or ornamental young vegetables against the attacks of greyworms (*Chenilles d'Agrotis*) and other insect larvæ, by M. A. Laboulbène; with remarks by M. Chambrelent.

Berlin.

Physiological Society, March 3.—Prof. du Bois Reymond, President, in the chair.—Dr. J. Munk gave an account of one part of the experiments on the nutrition of fasting-men, which he had carried out in conjunction with Messrs. Lehmann, Müller, Senator, and Zuntz. The same observers having some years ago made experiments on the fasting-man, Cetti, whose outcome was not in accord with the results of experiments made on dogs, they had more recently experimented again over a period of six days on another fasting-man, Breithaupt. This man's nutrition was followed for several days, on an ordinary diet, before the period of fasting, and again after the latter had ended. During the fast the patient was at liberty to consume as much water as he pleased, the amount taken being carefully noted. The following were the results of the experiments. The output of nitrogen sank slowly and continuously during the whole period of fasting. The urinary phenol increased in amount up to the fourth day (the sixth day in Cetti's case) and then sank to a minimum. Indol was only found in traces, and acetone was absent altogether. The amount of chlorine, as of alkali, diminished progressively, and continued below the normal even after food was once more taken. The urine contained a large quantity of phosphoric acid, as also of lime and magnesia. Prof. Zuntz reported on the respiratory interchange of the above man. When at rest the intake of oxygen was the same as that of a normally fed person twelve hours after a meal. The respiratory quotient varied from 0·66 to 0·69, and was thus less than that due to the oxidation of fats alone (0·7), or of proteids alone (0·8). During the fast the patient's power in turning a wheel against friction was the same as that observed when feeding, but fatigue set in much sooner, and was most marked in the cardiac muscles. During the earlier days of the fast, the consumption of oxygen when working was the same as for a normal person, but later on it became greater. The after-effects of work lasted longer than when food was taken. The speaker regarded the above extremely low respiratory quotient during the fast, as due to the possibility that the proteids split up into glycogen and some other substance, which was then oxidised and gave rise to the small quotient observed. In support of this view experimentswere made by Dr. Vogelius on the construction of carbohydrates in the fasting body. In the fasting animals on which the experiments were carried out, all glycogen was removed by moderately strong doses of strychnine. After this they were sent to sleep for eighteen hours by means of chloral-hydrate, and at the end of this period glycogen was found in considerable quantity both in their liver and muscles—glycogen which must presumably have been formed from the metabolism of their own proteids.

Meteorological Society, February 7.—Prof. von Bezold, President, in the chair.—The President gave a short account of a paper he had recently published in the *Sitzungsberichte* of the Berlin Academy on the thermal exchanges of the atmosphere, and entered into details as to the general propositions therein put forward. The latter are as follows:—1. The total radiant heat received by the whole earth in a year is equal to the total amount given off by radiation in the same period. 2. The total heat received by any portion of the earth or the atmosphere is on the average equal to that given off by the same portion. 3. The total heat received and given off in the course of a year is not the same for different portions of the earth or atmosphere: in some parts the amount received is greater than that given off, and *vice versâ*. 4. The heat received by given portions of the earth or atmosphere during any given period of the year is in general not equal to that passed off during the same period. 5. The total amount of heat taken in at the surface of the whole atmosphere during a given portion of the year is not necessarily equal to that given out at the same surface during the same period.

CONTENTS.

THURSDAY, APRIL 13, 1893.

THE PLANET MARS.

La Planète Mars et ses Conditions d'Habitabilité. Par Camille Flammarion. (Gauthier-Villars et Fils, 1892.)

IN this very handsome volume the author brings together every available observation and piece of information that can be gathered from published and unpublished works with respect to our sometimes very near neighbour, the planet Mars. To make such a compilation as this, is, as every one will acknowledge, no light task; and since up to the present no one has made any attempt to collect existing observations and discuss them (although perhaps the value of this book is the more enhanced thereby) the difficulty of the undertaking has been very considerable, but in such hands as M. Flammarion's it has been thoroughly mastered.

With regard, first, to the form of arrangement which the author has thought advisable to adopt—since in a work of this kind many courses are open depending on the standpoint from which the book is written—the writer might, in the first instance, have divided the text into chapters dealing with the climate, calendar, heat, mass, density, geography, &c., treating each of these at full length, and discussing all the observations bearing on each separately. That this would have formed a good and logical sequence is unquestionable, but it is accompanied by many drawbacks, the chief of them being that as observations increased and our knowledge consequently advanced, each part of the work would have to be rewritten, or, at any rate, undergo a thorough revision. The method actually chosen is one which will seem more simple and therefore appeal more to the astronomer, and will perhaps be productive of better discussion. M. Flammarion places the facts before the reader in simple, chronological order, tracing out the work on the planet from the very first observations, step by step, down to those made during the opposition of 1892.

The volume is divided into two main parts, the first including the exposition and discussion of the observations themselves, and the latter containing the conclusions that have been drawn from the study of all the facts. The interval from 1636 to 1892—that is the whole time covered by our records—is divided into three chief periods, the first two of which terminate in the years 1830 and 1877 respectively.

Dealing first with the period commencing with the observations of Fontana (1636-1638), we are at one of the most interesting parts of the book. Here the author has been plunging into all the old original records, and has treated us to the tit-bits both as regards illustrations and text. As we cannot here conveniently produce the earlier drawings of the planet as made by Fontana, but which are represented in this volume, we may at least give the original observations as recorded in words:—

"1636. Martis figura perfecte spherica distincte atque clare conspiciebatur. Item in medio atrum habebat conum instar nigerrimæ pilulæ.

"Martis circulus discolor, sed in concava parte ignitus deprehendebatur. Sole excepto, reliquis aliis planetis, semper Mars candentior demonstratur."

The second drawing, which was made on August 24, two years later, was accompanied with the text:—

"Martis pilula, vel niger conus, intuebatur distincte ad circuli, ipsum ambientis, deliquium, proportionaliter deficere: quod fortarse Martis gyrationem circa proprium centrum significat."

Following Fontana; Riccioli, Hirzgarter, Schyrle de Rheita, Hévélius, and Huygens (1656) were the next to make a special study of this planet, the last mentioned of whom added much to the knowledge of the planet's surface markings. Up to the end of this period (1830) the number of observers, and consequently the number of observations had very much increased, while the rapid stride made in the perfection of the telescope was not the least important factor in this advance. Summing up the conclusions which can be drawn from these 192 years of observations it may be said that they related more to the elements of the planet than to its surface features, although spots varying in size had been many times noticed; the general idea of the different shadings as representing land and water had been thrown out, and the polar caps had been recorded as variable and not coincident with the geographical poles.

The second period, commencing in the year 1830, opens with an account of the fine series of observations made by Beer and Mädler. It was about this time that the real geography of the planet's surface began to be better known, and a systematic method of mapping brought into vogue. Following these two workers come a host of others, all adding their mite, in some cases rather a large one, to solve the riddle relating to this orb. Among these we may mention; Warren de la Rue, Secchi, several of whose fine drawings are here inserted; Lockyer, whose drawings, sixteen of which appear here, and "sont les plus important pour la connaissance de Mars de tous ceux que nous ayons étudiés depuis les premières pages de cet ouvrage"; Phillips, Lord Rosse, Lassell, Kaiser, Flammarion, Trouvelot, &c. With such observers as these, and many others as able, but whose names are too numerous to mention, it is no wonder that good work was done, and our knowledge by the year 1877 greatly extended. More accurate values for the elements were deduced, land and water features confirmed, cloud drifts observed, variations in the polar caps again noticed, &c., in fact, to put it shortly, all observations pointed to a singular likeness of Mars, physically speaking, to the earth herself.

In the third and last period—the Martian cycle from 1877 to 1892—we have observations extending over as many as 239 pages of the volume. The epoch commences very appropriately with Prof. Asaph Hall's discovery of the two small satellites, and introduces to us the observations of Schiaparelli, whose work on this planet has been rewarded by such brilliant discoveries. To enter, however briefly, into the mine of interesting and valuable material here brought together would lead us far beyond the limits of this article, but we must leave it to the readers of this journal to refer to the book itself; suffice it to say that M. Flammarion has given each observer his just due and merit.

Arriving now at the second part, which gives the results deduced from the general study of the planet, M. Flammarion is also quite at home, and in his masterly way

brings all the main facts to a focus, sifting and sorting them and ultimately deriving the final results. In the following few brief extracts we propose to give in the author's own words some of the more important conclusions to which the examination of the facts has led him, and we will commence with the ruddy appearance that the planet puts on, the cause of which has always been and still is doubtful. *Apropos* of the suggestion that there may be red and not necessarily green vegetation on the surface of Mars, he says—

"Pourquoi, dira-t-on, la végétation de Mars ne serait-elle pas verte ?"

"Pourquoi le serait-elle ? répondrons-nous. La terre ne peut pas être considérée à aucun point de vue, comme le type de l'univers."

"D'ailleurs, la végétation terrestre pourrait être rougeâtre elle-même, et elle l'a été en majorité pendant bien des siècles, les premiers végétaux terrestres ayant été des lycopodes, dont la couleur est d'un jaune roux tout martien. La substance verte que donne aux végétaux leur coloration, la chlorophylle, est composée de deux éléments, l'un vert, l'autre jaune. Ces deux éléments peuvent être séparés par des procédés chimiques. Il est donc parfaitement scientifique d'admettre que, dans des conditions différentes des conditions terrestres, la chlorophylle jaune puisse seule exister, ou dominer. Sur la terre, la proportion est de 1 pour 100. Ce peut être le contraire sur Mars."

In a most interesting chapter comparing the Martial with the terrestrial seasons, many important points of similarity and difference are indicated. While the seasons of Mars are of nearly the same intensity as ours, yet the respective "working powers," so to speak, last nearly twice as long. The cold and hot seasons in the northern hemisphere continues for 381 and 306 days respectively, and it is this fact which explains the great difference between the two hemispheres. The polar caps, as with us, vary with the seasons, but attain their maxima and minima three to six months after the winter and summer solstices respectively. The dimensions which they assume cover in winter 45° to 50° in diameter, and become reduced in summer to 4° or 5°. Just outside the polar regions, "des chutes de neige ont été observées dans les régions tempérées, et parfois même jusqu'à l'équateur. On a vu dans l'hémisphère boréal des traînées en spiral venant du pôle, indiquant des courants atmosphériques influencés par le mouvement de rotation de la planète. La calotte polaire boréale paraît centrée sur le pôle. L'Australe en est éloignée à 5°, 4 ou 340 kilomètres, à la longitude 30°, de sorte qu'aux époques de minimum le pôle sud est entièrement découvert : *la mer polaire est libre*."

That actual changes have taken place on the planet's surface, in spite of the numerous sources of errors to which such delicate observations are liable, seems to have been proved by the discussion of the material. In speaking of these sources of errors he says, "Ces diverses causes de variations apparentes dans les aspects des configurations géographiques de Mars suffisent-elles pour rendre compte de toutes les variations observées ?"

"Non."

"Des changements réels ont lieu à la surface de la planète, changements qui n'ont rien d'analogue dans ce qui passe à la surface de la terre." . . . "Nous voulons parler de celle de l'étendue des taches sombres regardées comme mers, lacs ou cours d'eau."

The channels, the origin of which has been productive of so many hypotheses, are, according to the author, "dus à des fissures superficielles produites par les forces géologiques ou peut-être même à la rectification des anciens fleuves, par les habitants, ayant pour but la répartition général des eaux à la surface des continents." With regard to their doubling, after an examination of several hypotheses, he is led to look upon this fact as the result of refraction, although he remarks that "notre savoir est insuffisant," and "le connu n'est qu'une île minuscule au sein de l'océan de l'inconnu." He says,

"Quant aux dédoublements, il est difficile d'admettre que réellement de nouveaux canaux se forment du jour au lendemain, semblables et parallèles aux premiers : nous préférons imaginer qu'ils puissent être dus soit aux brumes dont nous avons parlé, soit plutôt à une double réfraction dans l'atmosphère martienne. Etant données les conditions de température (la chaleur solaire traversant facilement l'atmosphère martienne pour échauffer le sol), l'évaporation doit être très intense, et il doit y avoir constamment, au-dessus de ces cours d'eau, une grande quantité de vapeur rapidement refroidie, qui peut donner naissance à des phénomènes de réfraction spéciaux."

In the concluding chapter, giving us a *résumé* of the conditions of life at the planet's surface, the author sums up some of the main results. The world of Mars "paraît être, comme le remarquait déjà William Herschel, de toutes les planètes de notre système solaire, celle qui ressemble le plus à la nôtre. Nous pouvons répéter aujourd'hui, sur les habitants de Mars, ce que ce grand observateur écrivait, il-y-a plus d'un siècle, le 1er Décembre 1783 : 'its inhabitants probably enjoy a situation in many respects similar to ours.'" It is possible, he adds, that this world may be peopled with beings analogous to our own : a race superior and in a more advanced stage, for the globe of Mars, M. Flammarion holds, is an older member of the solar system than our own.

Such, then, is a general sketch of the contents of this handsome volume of 600 pages. A glance through it is sufficient to show that no pains have been spared either by the writer or by the publisher, which might in any way add to its completeness ; while the illustrations, which in such a work as this are of the highest importance, have been scattered with a lavish hand, and with all due regard to accuracy and purpose, no less than 580 telescopic drawings and 23 maps appearing.

In such a collection of facts as we have here, only one slight erratum has been observed, and this occurs on page 287, where it is stated that M. (now Prof.) Schur, at the observatory of *Breslau* made some measurements of the planet's diameter, while it should have been, "at *Strassburg* with a Breslau heliometer."

Throughout the work M. Flammarion has in every case given full references, which greatly enhances its value, while in the appendix several drawings made during the opposition of 1892 are inserted.

Never before was the planet viewed with such keenness by astronomers as was the case last year, and it is by these, as well as by those that have never had such an opportunity, that this work will be found of absorbing interest ; astronomical literature is considerably enriched by its appearance. William J. S. Lockyer.

MAGNETIC OBSERVATIONS IN THE NORTH SEA.

Magnetische Beobachtungen auf der Nordsee angestellt in den Jahren 1884 *bis* 1886, 1890 *und* 1891. Von A. Schück. (Hamburg: Selbstverlag des Verfassers, 1893.)

THE extended and valuable magnetic surveys—notably those of Rücker and Thorpe in England, and of Moureaux in France—which have been made during the last ten or fifteen years, have provided magneticians with considerable information as to the conditions of the earth's magnetism in the countries bordering on the North Sea. From such data, there should be no difficulty in calculating normal curves of the three magnetic elements for the comparatively small intervening region covered by that sea.

The surveys on land have, moreover, shown that there are several regions of local magnetic disturbance, and therefore the chief interest of a magnetic survey of the North Sea, would lie in the discovery from observation on board ship, whether local magnetic disturbance existed in the land under the sea. The settlement of such a point would be a valuable contribution to our knowledge of terrestrial magnetism, and certainly if large disturbance were observed in any locality, of great practical importance to navigation.

Captain A. Schück has, for some years, past been making observations of the three magnetic elements with a special set of instruments well designed for observations at sea. Great pains have been taken by him to eliminate all sources of instrumental error, and he selected those wooden ships which appeared to him so far free from iron in their construction, that his magnetic instruments when mounted on board would be undisturbed. The results of his four years' work are given in the text with full descriptions, and illustrated by drawings of the instruments, as well as a chart of curves of equal value for each magnetic element.

The execution of these charts leaves much to be desired, for the figures on the land are in many places so crowded together as to be almost illegible, and it would have been much more to the purpose, if the lines of equal values had been at once taken from the published maps of the several observers, whose work the author fully acknowledges, instead of crowding together the data upon which their lines are based.

Again, the curves for those regions covered by the sea are in places so abnormal that they invite inquiry as to the accuracy of the small number of observations upon which they in many parts depend.

Although the author gives general assurances as to the selected ships being free from any source of magnetic disturbance, there are really no results recorded, to show that the observations at sea were really free from the effects of iron in the several vessels on board which the magnetic instruments were used. Long experience shows, that unless specially built, no wood-built ship is so far free from iron that its action can be neglected, especially when minutes of arc in an observation are of importance.

If observations at sea over so small an area as the North Sea, and the channels south and west of Great Britain, are to effectually supplement those extensive magnetic surveys made on the countries adjacent thereto, they must be stripped of every source of error. It does not appear that the observations recorded in this work are of the exact order suitable to modern requirements, however useful they might have been many years ago.

A work like that undertaken by the author, requires a specially-constructed vessel, devoted for the time to magnetic observations and other subjects of scientific inquiry. His objects were evidently delayed in execution by insufficient means to a satisfactory end.

MANUAL OF DAIRY WORK.

Manual of Dairy Work. By James Muir, M.R A.C., Professor of Agriculture in the Yorkshire College, Leeds. 93 pp. (London: Macmillan and Co., 1893.)

THIS small primer on dairy work is in several respects a contrast to some of the books and pamphlets relating to dairy matters which have appeared within the last two or three years. Many of these have had too many points in common with a dairy utensil manufacturer's catalogue, and the information they contain has not always been either condensed or trustworthy. It is therefore a pleasure to take up Prof. Muir's little manual, which gives in small compass a great deal of information likely to be of value to every one interested in the production and use of milk. Apparently the book is intended for those who, having practical knowledge of the management of milk and its products, desire further knowledge of the principles upon which their practice is based, together with hints as to the best means of utilising their commodity according to the demands of their own particular market.

The information given is in most cases well up to date, but at the same time the discussion of obscure matters connected with the bacteriology of milk is carefully avoided. This is the more to be commended because every teacher of agriculture must know that looseness in describing the work of micro-organisms producing decay, or nitrification, or fixation of free nitrogen, has in many cases caused utter confusion in the minds of students; and more especially harmful is the imagination sometimes exercised by reporters and writers for the agricultural press. It is difficult to estimate the importance of Bacteriology in its relations to Agriculture and to Dairying, but in all discussion of the subject it is well to keep to ascertained and confirmed fact.

Prof. Muir's book is divided into ten chapters, the first of which deals with the formation and composition of milk. The description of the formation of milk in the udder is a trifle loose, the entire process being described as a casting off and breaking down of the cells which line the alveoli of the mammary glands. Milk is no doubt largely produced in this way, and especially must this be the case with colostrum when the glands commence or resume their activity; but it is more than probable that afterwards the milk is to some extent elaborated from the blood through the activity of the cells without so much actual shedding of the cells taking place. The great difference in composition between colostrum and normal milk shows that this latter process must be an important one.

In the third chapter some tests of the quality of milk are discussed. The value of milk is gauged by the percentage of butter-fat, and although there are many methods of estimating this, most of those which are trustworthy are troublesome to work. Prof. Muir does not speak well of the lactobutyrometer—an instrument designed for the separation and direct reading of the fat. The method is certainly rough, and almost useless, except in the hands of a very careful worker. There are two methods, not described by Prof. Muir, which are of much greater value and not more troublesome; these are the Babcock milk test and Soxlet's method of estimating fat in milk from a determination of the specific gravity of an ether extract.

In speaking of cream separation on p. 45, Prof. Muir mentions that "some kinds of separator have an arrangement for regulating the thickness of the cream," and also "that frequently separated cream is rather frothy." A fuller treatment of these points would have been useful. The methods of regulating thickness of cream from a separator depend upon varying the rate of revolution of the separator bowl, or else upon varying the time the milk remains in the bowl. The latter plan is most convenient, and is usually effected by diminishing the inflow of milk In the Danish separator the same end may be secured by adjusting the movable skimming tube. Frothiness of cream is most marked in the case of the Danish machine when the cream is taken off thick. This frothiness might possibly be remedied by using a smaller nozzle for the cream delivery tube.

In dealing with the principles of cheesemaking on p. 69, the author says, "The state of the milk with regard to acidity is of the greatest importance just when the rennet is added, and should it then be too acid little can afterwards be done to counteract the mistake. On the other hand, should the amount of acid be slightly too little, it may be counteracted to some extent in the subsequent processes."

As a matter of fact even the most skilful workers sometimes find the milk too ripe, and in such cases, by hastening the curd into the curd-sink and then washing with water at 100° F., good results may be obtained, at least by the "stirred-curd process."

The book concludes with a short appendix on cream-raising trials, made at the Yorkshire College.

Prof. Muir's manual, though small, is to be welcomed as a most useful addition to our dairy literature.

Walter Thorp.

OUR BOOK SHELF.

William Gilbert of Colchester, Physician of London, on the Loadstone and Magnetic Bodies, and on the Great Magnet the Earth. A New Physiology, Demonstrated with Many Arguments and Experiments. A Translation, by P. Fleury Mottelay. (London: B. Quaritch, 1893.)

Among men of science there is no difference of opinion as to the value of the original Latin work, "De Magnete," of which this is a translation. Some time ago (Nature, vol. xlii. p. 279) we gave an account of a meeting held at Colchester by members of the Essex Field Club and the Gilbert Club, for the purpose of doing honour to the memory of Gilbert, who was born there in 1540. In a speech delivered at this festival Lord Rayleigh not only spoke highly of Gilbert's work, but went on to say that although we owe to an investigator who lived so long ago the theory that the earth is a great magnet, we are not much in advance of that position at the present time, as nobody has yet explained the origin of terrestrial magnetism. It was most desirable that a work which may be said to have marked a definite stage in the evolution of physical science should be presented in an English form, and this has now been done by an American scholar, who, as he himself explains, has "translated with latitude, keeping in view the author's sense more particularly than his words, and amplifying without altering the former." Mr. Mottelay has also brought together in a short biographical memoir the leading facts relating to Gilbert's career. The volume is well printed on good paper, and will be very welcome to students of the history of scientific ideas.

Report on Manurial Trials. By Dr. William Somerville. (Newcastle: Ward, 1893.)

This pamphlet, extending to 61 pages, gives the results of manurial trials in the county of Northumberland during the season 1892.

The plan of the experiments is an extensive one, but we may say that many of the experiments are designed to show what manures can be economically applied in the growth of turnips and potatoes in ordinary rotation.

From the experiments made upon farms at Rothbury, Ilderton, Tweedmouth, and Wark-on-Tyne, Dr. Somerville concludes that (1) basic slag is the cheapes phosphatic manure, though the best result is obtained with a mixture of slag and superphosphate; (2) kainit up to 2 cwt. per acre is a profitable dressing to turnips and potatoes; (3) the turnip crop requires nitrogenous manure; and (4) small dressings of artificial manures are more directly profitable than large dressings.

It is to be hoped than many of these experiments will be repeated in the county this year. W. T.

The Food of Plants. By A. P. Laurie, M.A., B.Sc. (London: Macmillan Co., 1893.)

This little book is intended to be an introduction to agricultural chemistry. It contains descriptions of a series of simple experiments which may be undertaken without any previous knowledge of chemistry. These experiments illustrate the part played by water in the nutrition of plants, the nature of the soil and of the air, and how plants obtain their food from these sources, &c.

The experiments are carefully chosen and described, and can be performed with inexpensive materials, and the book, especially if used as the author suggests, in conjunction with a Chemistry Primer, can well be recommended as an interesting guide to the study of agriculture.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

Fossil Floras and Climate.

I have read with some interest the communications in recent numbers of Nature based on a review by my friend Mr. Starkie Gardner of a book which I have not yet seen; and as an exile in the south owing to a serious illness, I have not means of reference even to my own papers on the topic in discussion. I think, however, it may be well to direct attention to some Canadian facts published in the Transactions of our Royal Society and elsewhere, to which neither Mr. Gardner nor Mr. De Rance have referred.[1]

[1] See Report of Dr. G. M. Dawson on the 49th Parallel 1875; Reports Geol. Survey of Canada, 1871-'77-'79; Transactions Royal Society of Canada 1883 to 1892.

In Western Canada, in the Rocky Mountains, and in the Queen Charlotte Islands (latitude 55°) we have a lower cretaceous flora, characteristically mesozoic, and even allied to the jurassic. Two of its characteristic species are closely allied to *Divon eduli* of Mexico (*Divonites Columbianus* and *D. borealis*, Dawson). Along with these are species of *Zamites* and of *Podozamites*, and leaves of Salisburya, very near to those described by Heer from the so-called jurassic of Siberia. The lowest beds of this series contain no angiosperms; but in beds a little higher these begin to occur. This has been named in Canada the Kootanie flora, from the river of that name in the Rockies. The late Dr. Newberry, in one of his latest papers, described the same flora with identical species as occurring in Montana, and it coincides in part with the Potomac flora of Fontaine in the south-eastern states. Its character and distribution show an extension of warm climate from Florida to the Queen Charlotte Islands, coincident with a great northward extension of the warm waters of the Gulf of Mexico, which in my judgment is sufficient to account for the climatal conditions. This lower cretaceous flora may be considered to be Neocomian in age, and to correspond with the Wealden of England, and the Komé of Heer in Greenland, which shows the extension of at least a temperate climate beyond the latitude of 60°.

The middle cretaceous brought in a still greater extension of the warm Mediterranean Sea of interior North America, indicated by the chalky foraminiferal Niobrara beds of the United States geologists, which extend into Canada. North of these marine beds, however, we have in Canada, in N. lat. 55°, the Dunvegan sandstones and shales, which hold not only cycadaceous plants but a rich angiospermous flora, including such warm temperate genera as *Magnolia* and *Laurus*, with more northern forms as *Betula* and *Populus*. This we regard as a middle cretaceous flora, in its older part approaching the well-known Dakota flora of the United States, and corresponding to the Atané of Heer in Greenland. The climate in this period must have been humid, equable, and temperate, all around the great American Mediterranean; but it is not impossible that our Dunvegan collections may include some plants of mountain districts mixed with those of lower grounds.

This was succeeded by the upper cretaceous, in the older part of which we have the magnificent flora of the coal series of Vancouver Island, which represents a Pacific coast flora, with fan palms, live oaks, and other trees comparable with those of modern Georgia and Florida. By this time, however, there would seem to have been a geographical separation between the Pacific coast and the plains, as the latter have not yet afforded anything equivalent to the Vancouver flora, and there are some indications that, toward the close of the cretaceous, the climate was cooler than previously. This is equivalent to the Patoot series of Heer in Greenland.

The Laramie period proper, that of the lignite tertiary formations of the plains, seems to indicate a swampy and lacustrine condition of the interior plateau, and the rich angiospermous and gymnospermous flora of this time, characterised very markedly by species of *Platanus* and *Sequoia*, has a temperate aspect in Canada, as far north as the McKenzie river. It corresponds with the so-called miocene of Heer in Greenland, but is shown by stratigraphy and by its affinity with the eocene of England and Scotland, as described by Mr. Starkie Gardner, to be of that age if not constituting a transition group between the cretaceous and tertiary. The palæobotanists of the United States, at first, following Heer, regarded this flora as miocene. More recently some are disposed to consider it upper cretaceous. In Canada it has all along been regarded as paleocene or eocene, and so far as its flora is concerned this is its true position. In a recent number of NATURE I see that Prof. Osborn is disposed to regard the small mammalia of the Laramie of the United States as of eocene affinities. If so, they will agree with the plants. It seems more difficult to account for the great northward extension of the Laramie temperate climate than for that of the preceding cretaceous, as the great Mediterranean of the latter seems to have dried up, though still existing in part, or replaced by swamps and lakes. Possibly some other arrangement of the warm Atlantic currents, as suggested by Mr. Starkie Gardner, may have produced some effect, in conjunction with obstruction of the Arctic currents, and a lower level of Greenland.

The general bearing of these facts on American climate is that we have no evidence of a tropical climate in Northern Canada or Greenland, but that both the geographical and botanical facts indicate a warm temperate climate, at least in the cretaceous period, and that in the earlier eocene the climate was becoming cooler and less equable.

We have little to show for the miocene; but what there is, as in the Similkameen flora of British Columbia, would go to show a cooler climate and more of local variation.

I have little faith in attempts to deduce a mean temperature in degrees of Fahrenheit from fossil plants; but if carefully collected, so as to keep separate those that belong to different horizons, and if studied in strict relation to the geological conditions of their occurrence, they must afford excellent general indications of climate. Allowance must, however, be made just as in the case of animal fossils, for differences of station, altitude, &c., and for extent of probable driftage or occurrence *in situ*.[1] In studying large collections of our mesozoic and tertiary fossil plants, from different localities and horizons, I have as a geologist naturally had reference to these points, and the work of such men as Selwyn, Richardson, G. M. Dawson, and Mr. Connell has left nothing to be desired as to careful collecting and determination of stratigraphical relations, while the study of animal fossils by Mr. Whiteaves has gone on *pari passu* and in harmony with that of the plants.

I sympathise with Mr. De Rance in his defence of Heer's studies of the Greenland plants, for I know that my own work in Canada would be liable to still more severe criticism. It must be borne in mind that the palæobotanist has very imperfect material, and that he is always liable unconsciously to multiply species. If, however, his names serve to designate the things, and if their geological relations are known, an important work has been accomplished—always, however, provisional and liable to correction as new discoveries are made. One of my Kootanie leaves is scarcely distinguishable on the one hand from Heer's *Salisburya sibirica*, and on the other from Lindley's *Cyclopteris digitata*, even when I have specimens of both to compare it with. All may be the same, though referred on the one hand to ferns, on the other to coniferæ, and this may not be settled till specimens in fruit are found. But in any case something has been done, and a widely distributed vegetable form has been recognised at a particular stage of the world's history.

I hope to discuss some of these points more fully in a work now in the press. WM. DAWSON.

Augusta, Georgia, March 13.

P.S.—Since writing the above I have obtained access to a copy of Dall and Harris's "Neozoic Correlation Papers,"[2] which throws some additional light on the cretaceous and eocene floras of Alaska, which, from its high northern latitude, affords a good term of comparison with Greenland. It would appear that fossil plants occur at two horizons. One of these (Cape Beaufort), according to Lesquereux and Ward, holds species of Neocomian age, equivalent to the Kootanie of British Columbia and to the Komé of Greenland. The other, which occurs at several localities (Elukak, Port Graham, &c.), has a flora evidently of Laramie (eocene) age, and equivalent to the "miocene" of Heer and Lesquereux and to the McKenzie river and lignite tertiary of Canada. The plants are accompanied by lignite, and evidently *in situ*, and clearly prove harmony with Greenland and Northern Canada in two of those periods of high Arctic temperature indicated above.

Notes on a Spider.

I SEND you the following notes on a spider, whose curious habits I had an opportunity of observing, last year, on the West Coast of Africa:—

In the month of August, 1892, I was travelling by hammock from Chama to Sekundi, two small towns on the Gold Coast. That part of the country is somewhat hilly and is covered with "bush" and other forest growth. The road skirts the sea-shore, sometimes following the beach itself, at other times taking turns inland and winding round bases of small hills.

It was about three in the afternoon and I was being leisurely carried along by my bearers, when I noticed in the bushes that bordered the path something which appeared to me to be a sort of white flower.

[1] Ward, of the U.S. Geol. Survey, has directed attention to these points in an excellent paper published by the Survey.
[2] *Bulletin U.S. Geol. Survey*, 1892.

I stopped and examined it. Instead of being a flower, I found it was the web of a spider, and it was hanging between the branches of a shrub about three feet from the ground.

The outer lines of the web were of considerable strength and were stretched between points from eight to ten inches apart. From these lines, supported by a few radii, hung a beautiful rosette-shaped centre, much resembling a delicate pattern in white silk lace. The central space was open and measured about a quarter of an inch in diameter. The notched space was adorned by three circular zig-zag cords of thick white flossy silk. I did not notice any of MacCook's so-called "ribbon braces." The spiral space was very open and the threads composing it were so slight as to be almost invisible. So thin were they that the ribboned centre appeared to be hanging in the air without any support whatever. The appearance of this web was almost exactly similar to that of the web of *Uloborus*, shown in Fig. 57, p. 58 of MacCook's "American Spiders." I did not notice any "fenders" or protective wings on the outer side of the web; there were, however, a few strengthening strands on the side turned towards the bush.

The web, however, especially bore a strong resemblance to a flower, the more so as in the exact cêntre of its outward side was stationed a spider with a light blue body. This light blue colour gave one the impression that it was the centre of the flower, while the yellow legs spotted with brown were symmetrically disposed in the shape of an X across the ribboned hub, thus dividing it into the semblance of petals. The illusion was remarkable.

The spider remained motionless until I touched the web. She then fell into the net which I was holding under the snare.

As soon as she touched the net (a white gauze one) she changed colour. From blue she became white and then, on being shaken, her body turned a dark greenish brown. I then placed her in a glass tube and gradually she resumed her blue tint. Whenever shaken, however, she turned a greenish brown. I placed her in spirits and her colour remained a grey brown.

On the same road later in the day, I noticed another strange web which bore even a stronger resemblance to a flower.

The "foundation space" was the same as in the other, but somewhat larger and stronger. The white silk ribbon, however, instead of being disposed around the centre in circular zig-zag lines, was extended in two thick white ribbons stretched crosswise along four of the radii. In this instance also the spiral space was very open and the spirals very delicate.

The spider inhabiting this web was considerably larger than the foregoing specimen, but appeared to be otherwise exactly similar to it. Her body was a very light blue, placed exactly in the centre of the cross-head downwards, while her long legs were disposed in pairs over the four arms of the white silk pattern. The whole thing bore a great resemblance to an orchid, and the legs of the spider gave it just sufficient stability for it to be taken for a flower.

When I touched the web the spider immediately darted through two strands in the spiral space and placed herself on the reverse side of her web, being almost completely concealed by the thick flossy white ribbons.

I captured this spider, and her body, like the other specimen's, immediately turned a dark greenish brown. I did not, however, see her turn white. I placed the insect in a glass tube, and five days later put her in a cage.

I also took the web and succeeded in fastening the centre of it on to a black card, where it remains in exactly the same shape as when it was hanging on the bushes. I have this web, and also a photograph of it.

The day after the spider was placed in the cage she made a web. It was spun during the night, and I did not observe the operation. The web was of the same pattern as the one on which I discovered her on the bush. It did not have any circular zig-zag cords.

This spider remained in her cage for four or five weeks, and then I placed her in spirits. She was fed principally with flies.

On one occasion I put a very large blue-bottle fly into the cage. The spider seized it immediately, violently vibrated her web, and at the same time rolled the fly round and round between her legs. In the space of three or four seconds the fly was completely swathed in an envelope of white silk, and was motionless. The spider then fastened her fangs into the body, and sucked it for about two hours.

I have since seen several of these spiders on their webs, and have noticed that the pattern of the snare appears to depend on the size of the insect, the smaller specimens making the circular rosette-shaped snare, while the larger insects weave the cross orchid-like flower. I saw one small web composed of two little rosettes, joined side by side, but I did not notice whether it was inhabited by two spiders. I frequently found wings and other debris of insects hanging to the rosettes of the webs, and in one case saw a wing of what must have been a butterfly of considerable size.

When does the spider alter the pattern of her snare? Can it be that, when the spider attains to full growth, finding that the rosette shape, becoming too large, no longer deceives butterflies and other insects, she adopts the orchid-like pattern which has more *vraisemblance*, and over which she can dispose her long legs with a better chance of successful trickery.

The web of this spider being so like a flower would appear to be intended as a veritable "snare." The insect by assuming its bright blue colour increases the resemblance and the mimicry is probably practised not so much for the protection of the spider herself, but rather for the attraction it presents to butterflies and other flower frequenting insects.

MacCook in "American Spiders," writing of the mimicry of spiders, and of their perception of colour, says (vol. ii. p. 346):—"There is indeed another theory which may be suggested, namely, that the colour surroundings of the spider, in some manner not now explicable, so rapidly influence the organism of the creature that a change of colour is produced in harmony with its environment. *Can we suppose in this case that the spider possesses the power to influence at will the chromatophores or pigment bodies, so that she may change her colour with changing site?*"

The specimen observed by me would seem to be an answer to MacCook's suggestion, and I should be very glad to know, through the medium of NATURE, or otherwise, whether the spider described by me, as above, is already known to naturalists.

I took the specimens which I possess to the Natural History Museum, at South Kensington, and the spiders were declared to be a species of Argiope.

H. H. J. Bell,
Senior Assistant Treasurer, Gold Coast Colony.
20, Sussex Villas, Kensington, W.

Origin of Lake Basins.

One of the chief reasons for the prevalence of lake basisn in glaciated countries has not been alluded to in the letters which have recently appeared in NATURE on the origin of lake basins.

Whenever earth movements take place in limited areas such movements will tend to form basins, but as the movements are as a rule gradual such basins will only come into existence under exceptional conditions. Water-borne detritus, the growth of vegetation, and erosion will obliterate them in most cases as fast as they are formed by slow unequal movements of subsidence or elevation.

In glaciated countries, however, basins in the course of formation by unequal earth movements will be largely protected from such destructive action by being filled with ice, and will thus be preserved to appear as lake basins when the ice melts.

So, too, in countries where the rainfall is very small and the action of the forces destructive to lake basins is accordingly much diminished basins may be and are formed by earth movements. In rainless countries they are probably more numerous than we are aware of, for there is little to attract attention to them, but they will become of more importance as works of irrigation are required in such countries. An important depression, the Raiän basin, has lately been surveyed in Egypt by Mr. Cope Whitehouse with a view to utilising it for irrigation purposes (Proceedings Royal Geographical Society, 2nd series, vol. ix. p. 608).

Wind-borne detritus will tend to diminish the depths of such basins in rainless countries. So, too, the capacity of ice-filled basins to hold water in the future will be diminished somewhat by the erosion of the sub-glacial river, but on the other hand as the movement of the earth deepens the basin the ever-thickening mass of ice will acquire increased power to grind it deeper still. This grinding action cannot be ignored, and some shallow lake basins may be almost entirely due to it, but there is scarcely a limit to the formation of such basins by earth movements under suitable conditions.

J. C. Hawkshaw.
33, Great George Street, Westminster, S.W., March 29.

THE MUSK-OX.

THE Zoological Society of London being anxious to obtain living specimens of the musk-ox (*Ovibos moschatus*), well known as one of the characteristic inhabitants of Arctic regions, the Council of the Society have determined to offer the sum of five hundred pounds for five examples of this animal (two males and three females) delivered alive and in good condition in the Regent's Park Gardens, or a proportionate sum for a smaller number. It has been pointed out by Col. Feilden, in an article upon "Animal Life in East Greenland," published in *The Zoologist* for February last, that the southern range of the musk-ox, which was formerly supposed to be met with only in Arctic America, has now been satisfactorily shown to extend as far south on the east coast of Greenland as midway between the parallels of 70° and 71° N.L., and that it will in all probability be found in the future to extend along the coast line of Egede Land as far as the sixty-fifth parallel. Thus the abode of the musk-ox is brought comparatively close to Europe, and there seems to be no insuperable difficulty in procuring living specimens. Young musk-oxen are very easily reared and tamed, and there could not be any very great difficulty in catching either old or young in Jameson's Land.

Although the more southern portion of the coast of East Greenland is shut off from access by an almost impenetrable ice barrier, it has been ascertained of late years that the more northern portion of this coast may be reached with comparatively little difficulty. In 1889 Captain Knudsen, of the Norwegian sealer *Hekla*, landed on Clavering Island in 74° 10′ N.L., and found musk-oxen in considerable numbers. Again, during the recent Danish East Greenland Expedition of 1891-92, Lieut. Ryder managed to land on Jameson's Land in Scoresby's Sound, although the year was very unfavourable, and passed the winter there with great success, no sickness having occurred amongst the members of the expedition during all the time they were there.

Musk-ox (from Flower and Lydekker's "Introduction to the Study of Mammals," p. 358).

Animal life, Lieut. Ryder tells us, is rich, especially in Jameson's Land, where reindeer are seen in wonderful numbers. Many musk-oxen were seen around Hurry's Inlet, and traces of foxes, hares, bears, ermines, and lemmings were observed in Jameson's Land. The richness of vegetation (150 flowering plants having been gathered in Scoresby's Sound) and the size attained by it, especially around the western basin, are most astonishing, especially in comparison with what is the case on the western coast of Greenland.

It is, therefore, evident that it is quite possible for the well-equipped Arctic navigator to land on this part of the east coast of Greenland in almost any ordinary year, and that he will find there an abundant supply of both animal and vegetable life. In the former category are the musk-oxen, the young of which, as already stated, are easily captured and reared. When they are once placed on board ship there would appear to be no great difficulty in bringing them safe to England.

We subjoin the description of the musk-ox given in Flower and Lydekker's "Introduction to the Study of Mammals," the publishers of which (Messrs. Black) have kindly allowed us the use of the accompanying illustration.

The animal commonly known as the musk-ox (*Ovibos moschatus*), though approaching in size the smaller varieties of oxen, is in structure and habits closely allied to the sheep, its affinities being well expressed by the generic name *Ovibos* bestowed upon it by De Blainville. The specific name, as also the common English appellatives, "Musk-Ox," "Musk-Buffalo," or "Musk-Sheep," applied to it by various authors, refer to the musky odour which the animal exhales. This does not appear to be due to the secretion of a special gland, as in the case of the musk-deer; but it must be observed that, except as regards the osteology, very little is known of the anatomy of this species. It about equals in size the small Welsh and Scotch cattle. The head is large and broad. The horns in the old males have extremely broad bases, meeting in the median line, and covering the brow and whole crown of the head. They are directed at first downwards by the side of the face, and then turn upwards and forwards, ending in the same plane as the eye. Their basal halves are of a dull white colour, oval in section and coarsely fibrous; their middle part smooth, shining, and round; their tips black. In the females and young males the horns are smaller, and their bases are separated from each other by a space in the middle of the forehead. The ears are small, erect, and pointed, and nearly concealed in the hair. The space between the nostrils and the upper lip is covered with close hair, as in sheep and goats, without any trace of the bare muffle of the oxen. The greater part of the animal is covered with long brown hair, thick, matted, and curly on the shoulders, so as to give the appearance of a hump, but elsewhere straight and hanging down; that of the sides, back, and haunches reaching as far as the middle of the legs and entirely concealing the very short tail. There is also a thick woolly underfur, shed in the summer. The hair on the lower jaw, throat, and chest, is long and straight, and hangs down like a beard or dewlap, though there is no loose fold of skin in this situation as in oxen. The limbs are stout and short, terminating in unsymmetrical hoofs, the external one being rounded, the internal pointed, and the sole partially covered with hair.

It is gregarious in habit, assembling in herds of twenty or thirty head, or, according to Hearne, sometimes eighty or a hundred, in which there are seldom more than two or three full grown males. The musk-ox runs with considerable speed, notwithstanding the shortness of its legs. Major H. W. Feilden, Naturalist to the Arctic Expedition of 1875, says:—"No person watching this animal in a state of nature could fail to see how essentially ovine are its actions. When alarmed they gather together like a flock of sheep herded by a collie dog, and the way in which they pack closely together and follow blindly the vacillating leadership of the old ram is unquestionably sheep-like. When thoroughly frightened they take to the hills, ascending precipitous slopes and scaling rocks with great agility." They feed chiefly on grass, but also on moss, lichens, and tender shoots of the willow and pine. The female brings forth a single young one in the end of May or beginning of June, after a gestation of nine months.

ON THE CARBURISATION OF IRON.

II.

IN a previous communication (NATURE, vol. xlvi. p. 283) the problem of the distribution and absorption of carbon by iron has been discussed, and it has been shown that the process is akin to that of the solution of a salt soluble in water or an acid liquid, that at low temperature solution proceeds slowly, the solubility increasing with the temperature, until at the final high heat of Bessemer blown metal, or fluid nearly pure iron, the reaction is almost instantaneous; the carbon, and also manganese, contained in the spiegel-eisen used for this purpose diffusing throughout the fluid metal in a very short space of time. The same occurs when carbon only, in the form of charcoal or coke, is added in lieu of spiegel, as in the Darby process of carburising. By this latter process, however, about 30 per cent. excess of carbon must be added over and above the theoretical quantity required to insure a given percentage of carbon, for instance, ½ per cent. For lower percentages the excess must still be maintained, but with a corresponding diminution of the total weight of carbon used. In some instances more than 30 per cent. is used, according to the methods of procedure. In practice this holds good and the quantity of carbon required can thus be regulated.

A priori this would seem impossible. An excess 30 per cent. above the quantity necessary being used, it seems strange that, at the high temperature in the presence of a considerable excess of fluid metal, that nearly the whole of the carbon is not taken up, more especially when iron, as is well known, may absorb as much as 5 per cent. of carbon in the blast furnace; usually, however, cast iron contains not more than 4 and spiegel eisen 5 per cent. carbon, the latter alloy of manganese and iron apparently conferring greater solubility. It even suffices to pour the fluid metal on the pulverised carbon previously placed in the ladle, and a very even product is thus obtained, sufficing for all practical purposes, the variation in the percentage of carbon absorbed or dissolved falling within the limits of experimental error. It is possible that after absorption of carbon equalling say ½ per cent., if the iron were left in contact with carbon for a longer period, more might be taken up; and that with iron already charged with carbon, solution may be retarded; the rate at which the latter is taken up probably bearing a certain ratio to the amount previously absorbed. If carbon simply exists in solution this is very probable, and yet the theory would hardly afford at first sight a feasible explanation of the even absorption of carbon which thus takes place, were it not well known that most chemical reactions, so to speak, fall into the same category.

Chemical affinities are not entirely governed by actual values; or the affinity of one element for another; the mass or relative weight of the bodies present influences the final result; and it is conceivable that, assuming we have two bodies in solution, the addition of a reagent having a greater affinity for one of these may not, in the presence of an excess of the other, exert its full power, the greater mass or weight of the latter apparently weakening, or rather partly neutralising, the chemical force of the reagent added.

Further cases can be quoted where relative masses in solution are so evenly balanced that a slight excess of the reagent added determines the precipitation of one or the other at the will of the operator.

Barium sulphate is somewhat soluble in acids, and by prolonged digestion a portion is dissolved. Either barium or sulphuric acid may be precipitated by merely, as regards barium, adding a slight excess of sulphuric acid. On the contrary the addition of a little barium chloride determines the precipitation of sulphuric acid. Apparently, then, excess or mass of one element overcomes the greater affinity of the other for the reagent added, or, as often happens, a portion is left uncombined and in solution, requiring an excess of the reagent for the complete precipitation or combination.

Such cases as those above quoted are not uncommon in metallurgical processes conducted at high temperatures. Thus in the case of the manufacture of Bessemer steel, analysis indicates the presence of diverse elements existing together.

One has—silicon, carbon, hydrogen, oxygen, manganese—also sulphur and phosphorus together with, it is said, carbon monoxide in solution—also probably dissolved oxygen in addition to iron oxide. Further, steel with more than ½ per cent. of carbon, and also silicon and manganese in sensible quantities, always contains O and H; and thus we have the elements of water side by side in the presence of a tolerable excess of no less than three bodies, Si, C, and Mn, having affinities for oxygen.

It is quite true that the abnormally high temperature of the process may weaken ordinary chemical reactions by a species of dissociation; this has been acknowledged. Yet mass or relative proportions of the elements present must, one would think, influence final results, and thus prevent the complete elimination of the elements named for the reasons already stated.

The treatment of fluid iron with reagents such as C, Si, Mn, or alkalies, as now practised, is as strictly a chemical process as that pursued by the chemist in his laboratory. In both, reagents are employed which are known to be suitable for the elimination or precipitation of substances known to be present; and, so far as can be ascertained from actual practice, the steel-caster deals with molten metal containing certain elements in solution, and endeavours to get rid of some of these, or adds others assumed to be beneficial, just as the chemist works with solutions known to contain bodies possibly existing or combined with the fluid solvent in much the same manner as the worker with fluid iron. There seems but little difference, take it as one may; the same laws of combination, solution, &c., seem equally applicable; and differences of opinion as to what is really meant by the terms solution, chemical combination, or simply mixtures, are common to both. Further, it must not be forgotten that pure fluid iron, although exerting a direct solvent action on certain bodies, may take up or dissolve a chemical combination or double salt, just as pure water does. This, however, remains an open question, but it would be interesting to know if certain combinations of iron with other elements are thus held in solution.

As regards carbon there can be little doubt of the existence of definite carbides of iron; and it may be that combinations of iron with bodies other than carbon may play a part. Some recent work on certain alloys of iron points to the probability of the formation of these. Assuming the presence of a definite carbide of iron which may not be in solution, but diffused evenly throughout the fluid iron, although we cannot be absolutely sure of this, the behaviour of steel under certain conditions of heating and manipulation may be explained on the assumption that iron carbide, being certainly more fusible than pure iron, must become soft and plastic at a temperature at which the mass of pure metal is scarcely at all affected. This plastic compound would bind the noncoherent particles of the greater mass of iron together, and this mixed or heterogeneous body could be welded or beaten out under the hammer. It is the general opinion that the weldable metals are mixed bodies, are not homogeneous, inasmuch as bodies purely homogeneous cannot as a rule be welded together.

Wrought iron welds easily, far more easily than steel, and it is certain that the former is not homogeneous, whatever may be said of the latter. Wrought or puddled iron is well known as an irregular mixture, composed of grains

of pure metal intermixed with carburised metal, and also slag. The latter is said to play its part in rendering the total mass more coherent when heated and worked. This latter material when fused and cast into ingots is a totally different material, and behaves somewhat like steel. If this now comparatively homogeneous substance contain enough carbon (which sometimes is not the case; in the latter instance it is brittle and redshort, behaving somewhat like Bessemer blown metal) it works like a soft steel.

It follows, therefore, that if fusible compounds are present, and evenly diffused throughout the pure metal, their effect on steel is purely physical, and a heterogeneous metal like steel may be compared with rocks, which are known to be composed of siliceous particles, cemented or bound together by other compound bodies. Dr. Sorbys long ago noted this, and drew attention to the comparative uselessness of ordinary chemical elementary analysis, simply stating the percentage of elements present, and suggested that proximate analyses were equally required. The writer is fain to agree with him, his own experience of the comparative failure of ordinary analysis as a trustworthy guide in the manufacture having been somewhat extensive. The purest form of iron known to the writer is the Bessemer blown metal, beyond traces of carbon, with less than $\frac{1}{10}$th per cent. of sulphur and phosphorus. It is pure iron (with some kinds of iron only traces of these latter can be detected). This metal is worthless for commercial purposes, and this is said to be due to the presence of oxide of iron or possibly dissolved oxygen absorbed during the blow; to a certain extent this has been proved to be true. But the writer thinks that on the whole the pure material, even when freed from oxygen, would be commercially valueless, and if, shortly speaking, the cement theory or mixture of bodies (the one more fusible than the other), be true, pure iron is unworkable.

The opinions quoted are apparently not in accord with the theory of solution previously summarised, and leave unexplained the undoubted fact of the diffusion or solution of carbon in iron at low temperatures, tending, of course, if time be allowed, to the formation of a homogeneous material. Yet a carbide of iron is known, "Fe_4C," and has been isolated. It appears to the author that one somewhat reasonable explanation of this anomaly has been afforded by W. Mattieu Williams. He compares the union of carbon and iron to the processes of tinning or galvanising. If a plate of copper is immersed in melted tin a film of tin adheres to its surface, and if continued the tin will gradually soak into the copper, and in time will go through. Tin or zinc penetrates iron in the same way; mercury also amalgamates with copper; therefore carbon (Fe_4C) may be similarly distributed in iron.

This may or may not be the case, but in the author's opinion it does not meet all the difficulties, or afford a complete explanation of the phenomena taking place when iron is heated and worked in contact with carbon. Neither does the alternative theory of solution, either in the ordinary sense of the word or, better, as defined by modern physicists, afford a complete explanation. Yet on the whole the latter seems to afford a better and more complete all-round explanation of some curious changes observable when steel is heated up to certain varying temperatures, the results of which are now familiar to us.

Referring once again to the curious fact of the even distribution of carbon throughout iron, when plates of uneven composition as regards the percentage of carbon are heated together, it appears as the outcome of recent research[1] that chemical action, "or something closely approximating to it," takes place between solids, and even at low temperatures. Many experiments are given—thus dry ice and rock salt unite when placed in contact at a temperature decidedly below zero.

This is a very old experiment, but it is interesting as an example of the union of two solids below the fusing point of either, but above that of the product. He obtained similar results in other cases with sodium, potassium, calcium, and ammonium chloride, &c. This suggests the question, Are the metals combining to form an alloy "in the new way," *i.e.* in the form of solids, a freezing mixture?

Space does not admit of further quotation; the fact remains that solids combine with solids to form an alloy, or possibly what is termed a chemical combination.

At first sight this seems inconceivable and irrational. Many alternative theories and explanations of these curious phenomena are at our disposal. Yet there remains one simple way of accounting, at least in some degree, for this alloyage—or one ought perhaps to say the interpenetration of one element into another, as with carbon and iron. It is now, we think, generally admitted, in the light of recent researches on the vaporisation of the elements, "both in vacuo and at ordinary pressures," that no known element, however infusible, can be said to be *perfectly* stable at any temperature when freely exposed in space; and it is extremely probable that even such substances as iron and carbon are slowly dissociating at ordinary temperatures very much as water evaporates, and it follows that these are always enveloped in a thin atmosphere of their own vapour. The *quantity* of matter present in this form may never be recognisable; it may indeed be beyond the limit of our senses. Yet if such a process takes place, it affords a probable explanation of the diffusion of solids into each other. For admitting this it is evident that any mass or mixed masses of matter exist in an atmosphere formed by themselves. Such masses of matter cannot be discontinuous, strictly speaking, the sensible particles of which they are composed are not completely isolated from each other, and from this point of view the conception of the interpenetration of iron by carbon, or indeed other bodies, is, one thinks, rendered more easy.

John Parry.

[1] William Hollock, *American Journal of Science*, vol. xxxvii. 1889.

NOTES.

Botanists all over the world will be sorry to hear of the death of the famous Swiss botanist, Alphonse de Candolle. He was in his eighty-seventh year. We hope to give on a future occasion some account of his services to science.

We regret to hear, through the *Botanical Gazette*, of the death of the Rev. T. Wolle, pastor of the Moravian Church, Bethlehem, Pennsylvania, an ardent student of freshwater algæ. Of his three most important publications, "Freshwater Algæ of the United States," "Desmids of the United States," and "Diatoms of the United States," at least the first two will always be standard works in the subject of which they treat.

The ordinary general meeting of the Institution of Mechanical Engineers will be held on Thursday evening and Friday evening, April 21 and 22, at 25, Great George Street, Westminster. The chair will be taken at half past seven p.m. on each evening by the president, Dr. William Anderson, F.R.S. The following papers will be read and discussed, as far as time permits:—Second report to the Alloys Research Committee, by Prof. W. C. Roberts-Austen, F.R.S. (Thursday, and discussion possibly continued on Friday); tensile tests and chemical analyses of copper plates from fire-boxes of locomotives on the Great Western Railway, by Mr. William Dean (in connection with the above report); Research Committee on marine-engine trials: abstracts of results of experiments on six steamers, and conclusions drawn therefrom in regard to the efficiency of marine boilers and engines, by Prof. T. Hudson Beare. The anniversary dinner will take place on Wednesdayevening, April 19.

THE Council of the Marine Biological Association of the United Kingdom have appointed Mr. Edward J. Bles director of the Laboratory at Plymouth. Mr. Bles has held an honorary research fellowship in zoology at the Owens College, Manchester.

THE seventh annual photographic conference, organised by the Camera Club, was opened yesterday in the theatre of the Society of Arts, under the presidency of Captain Abney. Various papers were read, and others are to be read to-day. The annual exhibition of photographs by members will be on view at the club after conference week, and will remain open for about six weeks.

THE thirteenth annual general meeting of the Essex Field Club will be held at Chelmsford on Saturday, April 15. It is proposed that before the meeting the members shall have a ramble in the neighbourhood of Chelmsford, and thus open the field meetings for the season. After the transaction of official business an address will be delivered by Dr. Laver, the retiring president, on "periodicity in organic life." His object will be to show that animals have periods of abundance and rarity, and that this is not due either to meteorological causes or to the agency of man.

THE Council of the City and Guilds of London Institute, recognising the increasing importance in the mechanical reproduction of pictures, will, in the forthcoming examinations, to be held on May 3 and 13 next, give special importance to this branch, by dividing the examination in the Honours Grade into two classes, one for pure Photography, and the other for photomechanical Photography. Special examiners have been appointed for each branch, and candidates have the option of declaring in which branch it is their intention of entering. They will not, however, be allowed to compete in both branches. The certificates granted will show in which of the two divisions the candidate has passed. The Council of the Institute hope that the encouragement thus given to the photo-mechanical division will tend to form in this country a school of competent craftsmen in this branch of photographic work.

THE twenty-fourth annual meeting of the Norfolk and Norwich Naturalists' Society was held recently at the Museum, Norwich, the president (Mr. H. B. Woodward) in the chair. Mr. T. Southwell was elected president for the ensuing year, and after the usual routine business the retiring president delivered the annual address. After giving some account of the work of the society during the session, he remarked that there was a slight increase in the number of members; also that the financial position was satisfactory. Turning attention to the geology of Norfolk, he expressed regret that the gaps left by the deaths of the older geologists were not filled by new-comers. Even collectors of fossils, who rendered such good service, were not nowadays so plentiful as formerly. Enthusiasm was damped by the difficulties in naming specimens, and these difficulties were increased by modern palæontological work. There were varieties of species which co-existed with the type; and there were variations which followed the type in chronological succession, and to the latter the name "mutations" had been given. He regarded the giving of specific names to these mutations as the most serious obstacle ever placed in the pathway of the student of nature. Allusion was made to the subject of geological "zones," and mention was made of the discovery of layers of phosphatic chalk in Buckinghamshire, and to their possible occurrence in Norfolk. Having referred to various other matters, Mr. Woodward expressed a hope that some day Norwich might have a university college, where prominence would be given to subjects of special practical importance in East Anglia.

SIR THOMAS GRESHAM'S Reader in Geometry at Gresham College being unable, owing to ill-health, to give the Easter course of lectures, the City Side of the Gresham Committee have permitted their delivery by deputy. The following course of lectures on special applications of the laws of chance is to be given:—April 18, "On Frequency Curves, their Nature, Variety, and Use," by Dr. John Venn, F.R.S.; April 19, "Chance in the Field of Biology," by Prof. W. F. R. Weldon, F.R.S.; April 20, "On some Points in the Philosophy of Chance," by the Rev. W. A. Whitworth; April 21, "Probability as the Guide of Astronomers," by Sir Robert S. Ball, F.R.S., Lowndean Professor of Astronomy in the University of Cambridge. The lectures are free to the public, and begin at six o'clock p m.

MISS CAROLINE A. FOLEY contributes to the new number of *Mind* a vivid and very interesting account of the late Prof. Croom Robertson as a teacher. No one who reads it will have any difficulty in understanding the affection and respect with which his memory is cherished by his old pupils. Miss Foley, while regretting, as many others have done, that Prof. Robertson did not live to present "an integral view of his thoughts on any great questions of philosophy," suggests that some who heard him give expression to his ideas may have in their possession as much recorded material as would enable "any of his more competent contemporaries to synthesise and perpetuate what of it is chiefly and worthily distinctive." The editor of *Mind*, in a note, states that "this suggestion will probably be carried out."

A REPORT of the first annual meeting of the Association of Head Masters of Higher Grade and Organised Science Classes has been issued. The meeting was held lately at Manchester, the chair being occupied by Mr. James Scotson, of the central higher grade school, Manchester. The report includes not only Mr. Scotson's address, but a vigorous paper by Dr. David Forsyth, head master of the central higher grade school, Leeds, on "higher education for the children of the people."

ON April 8 several shocks of earthquake were felt over a wide area of south-eastern Europe. They were especially severe in western Servia. Shocks were also felt in Bulgaria and at various places in Hungary. They are said to have occurred in Hungary between 2 and 3 o'clock in the afternoon, in Servia at 2.55 P.M., at Sofia about 4 o'clock P.M. From Sofia the movement is reported to have been of an undulatory character and to have lasted about thirty seconds, the direction being from west to east. On Sunday and Monday fresh shocks were experienced in various parts of western Servia, but they were less severe than those of the previous day. According to a Reuter's telegram from Belgrade, the districts most seriously affected by the earthquake of Saturday are those of Morava and Pozarevac. Great damage was done in the towns of Svilajinac and Gradista, where the shocks followed one another in quick succession. At Livadica-Cuprija, as well as at Svilajinac, great fissures were opened in the earth, whence streams of water and quantities of yellowish matter were still issuing forth on Monday. Thousands of houses and a great number of churches are either in ruins or have become so severely cracked that the people are afraid to enter them. So great is the panic in the two districts named that not a single person ventures to sleep indoors.

MR. W. R. ELLIOTT, writing to us from Prince Ruperts, Dominica, W.I., on March 19, says that the northern end of the island of Dominica had for some time been the scene of what he calls "a most extraordinary display in the way of earthquakes." The house in which he was staying at the time is situated on a spur off the main ridge of the island, and, therefore, somewhat in the direct line of volcanic action in these islands. The shocks began on February 17, and were felt

occasionally until March 18. They seem to have been most intense on March 12. Mr. Elliott says with regard to the shocks on that day:—"The shocks between 7.10 p.m. and 7.20 p.m. were very sharp, and followed one another rapidly. The sharp succession of shocks at 3.10 a.m. on the 13th inst. very much resembled this batch. The loud roar that accompanied each shock was very noticeable, and we could hear it distinctly immediately before each shock, in fact, could hear the earthquake coming along the hills to us. None of the shocks had that long undulatory motion that is usually felt when we have an earthquake that is felt throughout the islands, but the feeling was that we were being heaved up and twisted round, and the bumps seemed to give us a push northwards, and I could not help imagining that we were being pushed up to Guadaloupe. I mention this as showing how marked was the direction of the shocks. After 3.10 a.m. on the 13th the shocks became so frequent that I stopped noting them down, until after a short lull a sharp one was felt at 9.15 a.m."

THE weather has continued very fine over the British Islands during the past week, scarcely any rain having fallen in any part. With a very trifling exception in the south and east, the drought has continued since March 4, and in the south-east of England there has been no rain for upwards of three weeks. The temperature has been somewhat lower generally in the daytime, although in the inland and southern portions of the Kingdom the maxima during several days varied between 60° and 70°, but at the eastern coast stations the maximum temperature on several days did not exceed 45°, owing to the sun's rays being obscured by cloud and fog. During the latter part of the period the barometer fell slowly but uniformly; in the north of our islands the weather became less settled, and on Tuesday snow was falling in the Shetlands, still the general conditions indicated a probable continuance of dry weather, and an anticyclone in the north was spreading southwards. The *Weekly Weather Report* of the 8th instant showed that the percentage of bright sunshine for that period ranged from 38° to 60° in Scotland, from 53° to 66° in Ireland, and from 61° to 74° in England, while in the Channel Islands it was as high as 79°.

A SUMMER excursion to the Giant's Cause way for scientific study is being organised by Mr. C. Carus-Wilson. It is proposed that the party shall start for Portrush on July 1 or earlier, and return, if possible, through Dublin, so that they may have an opportunity of meeting the members of the Geologists' Association, who are this year to visit the Wicklow Mountains.

WE have received a copy of a new prospectus of the electrical and general engineering college and school of science, Penywern House, of which Mr. G. W. de Tunzelmann is principal. It gives an account of recent extensions, and of others which are in progress.

IN the "Annals of Natural History" for the present month will be found an account of a very interesting zoological novelty. Mr. R. T. Günther describes and figures a remarkable new form of *Medusa*, or jelly-fish, that occurs in Lake Tanganyika. Until recent years, when the little *Limnocodium* was found living in the Victoria Lily-tank of the Botanic Gardens, Regent's Park, it was believed that the *Medusæ* were nearly exclusively oceanic. It is now shown that the freshwater lake Tanganyika is the home of a peculiar member of this group. The existence of such an organism in Tanganyika was asserted some years ago by the German naturalist, Dr. Boehm, and Prof. v. Martens, of Berlin, even went so far as to name it *Tanganjicæ*, although he had never seen a specimen. Mr. Günther now supplies us with a full description of this singular Hydrozoon, which he refers to a new genus, *Limnocnida*, adopting the suggestion of v. Martens as to its specific name. *Limnocnida tanganjicæ* is, as might have been anticipated, perfectly different from all the members of the group hitherto known, and probably represents a distinct family, but its exact position cannot be settled positively until the mode of its development has been ascertained.

A GOOD descriptive article on the prehistoric remains at Abury is contributed by Mr. A. L. Lewis to *Science* of March 24. The editor appends a note in which he says it has been thought that many Americans who, when in England, visit Stonehenge, may not be aware how many remains of a similar character, which they might also wish to inspect, exist in the British Isles. He has accordingly made arrangements for a series of short articles which shall give a description of each of the principal circles, and state what points should be noted and how it may be most easily visited.

MR. H. L. JONES records, in the *Botanical Gazette*, an example of a graft-hybrid between two different varieties of geranium, a red and a white. In several successive years the flowers partook of the characters of both parents; some were pure red, and others pure white; others had some of the petals white, others red; while in others again the petals were red mottled with white, or white mottled with red.

IF we may judge from the tone of an article on "conditions of forestry as a business," contributed by Dr. W. J. Beal to the New York *Engineering Magazine*, a good deal of anxiety is felt by some Americans about the extraordinary rapidity with which trees are vanishing from their country. Michigan had at one time a supply of standing pine which was believed to be well-nigh inexhaustible. Now it is found only in "small tracts in the back counties." The fathers and grandfathers of the present generation of Americans "cut down and burned the finest of the trees to make room for crops and pasture." "We have been taught," says Dr. Beal, "to destroy trees, not to save them—much less to replant." The growth of interest in forestry will, he thinks, be slow for some time yet, but he anticipates that popular feeling about the matter will be greatly changed, and that salutary laws will be passed, before the close of the present century.

MR. L. J. TREMAYNE notes, in the current number of the *Entomologist*, that he was walking down the Thames Embankment about two o'clock on March 8 (the sun being just at the time rather powerful), when a specimen of *Vanessa polychloros* alighted on the pavement about a couple of yards from him. The insect was, he thinks, perfect, and appeared very fresh. He tried to catch it, but it flew into the gardens on his left, and he saw no more of it. There was, however, no mistaking the specimen, which expanded its wings right in front of Mr. Tremayne. This occurred just above Waterloo Bridge.

AT the Technical Institute of St. Petersburg, M. Vladimiroft has deduced from experiment a set of rules for estimating the quality of vulcanised caoutchouc (*Rev. Sci.*). Recourse is had to physical properties, chemical analysis not giving any sure result. The following, in brief, are the conclusions:—(1) Caoutchouc should not give the least sign of cracking when bent to an angle of 180°, after 5 hours' exposure in an air-bath at 125° C. (the specimens 2·4 in. thick).. (2) Caoutchouc having not more than half its weight of metallic oxides should bear stretching 5 times its length before rupture. (3) Caoutchouc exempt from all foreign matter except sulphur should be capable of stretching at least 7 times its length before rupture. (4) The extension measured just after rupture should not exceed 12 per cent. of the original length (with given dimensions). (5) Suppleness may be determined by calculating the percentage of ash after incineration. This may form the basis of choice for certain uses. (6) Vulcanised caoutchouc should not harden in cold. These rules are adopted for the Russian Navy.

The French Minister of War has recently had some experiments made on the resistance of ice. With a thickness of 4 centimetres (say 1·6 inches), it begins to bear the weight of a man marching alone; at 9 centimetres detachments of infantry in files may go on it; at 12 centimetres it will carry "pièces de 8" on carriages, and so on; till at 29 centimetres, it will bear the heaviest weights. M. Forel (*Rev. Sci.*) sees danger in this note; if an officer, trusting in the figures, ordered a troop on ice of measured thickness, he might, in some cases, be courting catastrophe. Those estimates, in fact, apply only to young ice, lamellar ice in process of freezing. When ice has for a few weeks been subject to alternations of temperature it changes in structure and loses much of its tenacity. The old ice of a pond, absolutely compact in appearance, is traversed by a multitude of vertical fissures dividing it into irregular prismatic needles, comparable in arrangement to columns of basalt, and from a half-centimetre to 1 or 2 centimetres in thickness. The structure becomes evident on breaking suddenly, in sunlight, a block of ice taken from a pond. Under these conditions old ice has not nearly such resistance as young ice.

The Michigan Mining School has published a "Catalogue," in which a full account is given of the various departments of its work. The institution was established and is supported by the State of Michigan "in accordance with that liberal educational policy which has placed the university of Michigan amongst the foremost educational institutions of America." It is stated with admirable directness that students at the school are supposed "to understand what they are there for, to attend strictly to that business, and to conduct themselves as gentlemen."

The new number of the *Internationales Archiv für Ethnographie* (Band vi., Heft i.) is occupied wholly with the concluding part of Dr. W. Svoboda's interesting notes (in German) on the inhabitants of the Nicobar Islands. The illustrations, as usual, are excellent.

The American Philosophical Society, Philadelphia, has issued a new instalment of its Proceedings (vol. xxx., no. 139). It opens with a paper on the mutual relations between the orbits of certain asteroids, by Daniel Kirkwood. There are also articles by Dr. D. G. Brinton on the Betoya dialects, and on the Etrusco-Libyan elements in the song of the Arval brethren; and by Prof. E. D. Cope on the phylogeny of the vertebrata (with two cuts), on some points in the kinetogenesis of the limbs of vertebrates, and on false elbow joints (with two plates).

A "Catalogue of Australian Mammals, with Introductory Notes on General Mammalogy," by J. D. Ogilby, has been published by order of the trustees of the Australian Museum, Sydney. Mr. E. P. Ramsay states in the preface that the work contains descriptions of all known mammals indigenous to Australia, with notes on allied fossil forms, compiled from various sources which are duly acknowledged by the author. Nearly all the species, Mr. Ramsay says, are represented by one or more specimens in the Museum.

The new number of *Records of the Australian Museum* (vol. ii. no. 4) contains the following papers:—On further traces of *Meiolania* in N. S. Wales, by R. Etheridge, jun.; notes on Australian Aquatic Hemiptera (No. 1) by Frederick A. A. Skuse; remarks on a new *Cyria* from New South Wales, by Frederick A. A. Skuse; geological and ethnological observations made in the valley of the Wollondilly River, at its junction with the Nattai River, Counties Camden and Westmoreland, by R. Etheridge, jun.

A volume on "Ironwork from the Earliest Times to the End of the Mediæval Period," by J. Starkie Gardner, has been issued as one of the South Kensington Museum art handbooks. It is mainly artistic, but the author has a good deal to say that is of scientific interest, and his scientific training enables him to present in an orderly way the historical facts with which he is chiefly occupied. Ironwork of later times will be dealt with in a second volume.

Some time ago Mr. C. E. de Rance prepared for the information of the County Councils a very useful map of the river basins in England and Wales, the object being to define the natural jurisdiction of joint committees of county councils for the prevention of pollution of rivers under section 14 (iii.) of the Local Government Act, 1888, and other matters requiring united control. The map has now been reprinted by J. E. Cornish, Manchester.

The Geological Survey of Canada is issuing a valuable series of "Contributions to Canadian Palæontology." The fourth part of the first volume, by J. F. Whiteaves, has just been published. It deals with the fossils of the Devonian rocks of the islands, shores, and immediate vicinity of Lakes Manitoba and Winnipegosis, and is well illustrated.

The York School Natural History, Literary, and Polytechnic Society has issued its fifty-ninth annual report. Much genuine interest in science is evidently maintained among the members of this society by the part they take in its work. The Natural History Club held in the course of the year twenty-three meetings, sixteen of which were occupied with the club's regular business of reporting and commenting on finds and observations.

The first part of an elaborate "Topographische Anatomie des Pferdes," by W. Ellenberger and H. Baum, has just been issued, the publisher being Paul Parey, Berlin.

A new sclerometer, constructed by M. Paul Jannetaz, was recently presented to the French Academy of Sciences. Like that invented by Seebeck, it measures the hardness of bodies defined as their resistance to scratching. It consists essentially of a platform rendered horizontal by means of leveling screws, and furnished with various motions which enable the observer to place any part of the body whose hardness is to be determined underneath a vertical point. This point is carried by an arm of a balance, which can be adjusted by a coarse and a fine movement, so as to bring the point and the body into contact without a shock. The beam is provided with pans carrying the weights which produce the pressure. At one extremity the beam carries a screw for horizontal adjustment, at the other a hollow bar to hold one of a set of points, such as copper or steel points of various angles, straight or curved, forming certain definite angles with the platform when mounted, or crystalline points clamped in metallic jaws. A very light aluminium beam is used for bodies which are only tested with light weights. As a rule the points trace a small circle on the body, which, when examined under the microscope, indicates the hardness of the substance in various directions. Homogeneous bodies like metals need only be moved in one direction. The scratch is viewed by reflection, greater softness being indicated by greater breadth. An interesting fact concerning the relative hardness of copper and zinc has been brought to light by means of this apparatus. Most authors regard zinc as harder than copper. If, however, the metals are examined in a sufficiently pure state, it appears that copper is the harder of the two. This removes an exception to the rule that the harder the body the less its atomic volume.

In a paper communicated to the Royal Prussian Academy of Sciences (see also *Electrician*, vol. xxx. p. 660) Dr. Philipp Lenard gives an account of some interesting experiments on the rays given out by the kathode of a Geissler tube which produce phosphorescence. Thin metal plates being to a great extent transparent to these rays by

closing a small hole in the observing tube by a plate of aluminium 0·003 mm. thick, it was possible to study their properties outside the tube. It was found that the rays produce a slight luminosity in air, and when they fall on phosphorescent bodies, held near the window, cause the latter to shine with the same light they show when enclosed within the vacuum tube itself. The brightness diminishes rapidly as the distance from the window increases, so that in air all glow ceases at about 6 cm. On bringing a magnet near the tube so that the kathode rays no longer fall on the inner surface of the window, all phosphorescence ceases without the tube. A quartz plate half a millimetre thick entirely stopped the rays; ordinary gold, copper, and aluminium leaf, however, allowed them to pass almost undiminished. In air at the ordinary pressure these rays are not propagated in straight lines but are diffused, so that it is impossible to obtain a sharp shadow of a body placed between the window and the phosphorescent substance. As these waves cannot be generated in a high vacuum it has been up to now impossible to say whether they are only propagated when matter is present. By enclosing the observing tube in another, the author has shown that in the best vacuum attainable with a mercury pump, these waves are transmitted with as great facility as in air at the pressures ordinarily existing within Geissler tubes. Different gases transmit the rays to very different extents, thus, with hydrogen at atmospheric pressure, phosphorescence is produced in a body placed at a distance of 20 cm. from the window. These experiments seem to show that while for light of the smallest known wave-length the matter behaves as if it completely filled the space it appears to occupy, in the case of these kathode rays even gases behave as non-homogeneous media, and each separate molecule acts as an obstacle diffusing the rays.

NOTES from the Marine Biological Station, Plymouth:—Recent captures include the Polyclada *Eurylepta cornuta*, *Cycloporus papillosus* and *Leptoplana*, the Actinian *Zoanthus Couchii*, and the Opisthobranchs *Scaphander lignarius* and *Ægirus punctilucens*. The sea has lately become increasingly richer in diatoms and floating algæ, esp. *Coscinodiscus*, *Rhizoselenia* and the so-called "gelatinous alga." In the floating fauna the Dinoflagellate *Ceratium tripos* has been constantly plentiful throughout the winter; *Noctiluca* is very scarce. Of the Hydroid medusæ, small *Obeliæ* are still abundant; medusæ of *Clytia Johnstoni* are generally present; and Forbes's *Thaumantias octona* has been again observed. The Actinian larva *Arachnactis* occurs in most townettings. Zoææ of *Porcellana* have slightly increased in number. The Actinian *Bunodes verrucosa* (= *gemmacea*) is now breeding.

THE additions to the Zoological Society's Gardens during the past week include a Leopard (*Felis pardus*) from India, presented by Admiral W. B. Kennedy, R.N., F.Z.S.; a Common Squirrel (*Sciurus vulgaris*) British, presented by Miss Edith Mackenzie; two Black Rats (*Mus rattus*) British, presented by Mr. Sydney Wedlock; a Panama Amazon (*Chrysotis panamensis*) from Panama, presented by Mrs. Mackey; a European Pond Tortoise (*Emys europæa*) European, presented by Mast. J. F. Harben; a Macaque Monkey (*Macacus cynomolgus*) from India, deposited; a Common Pintail (*Dafila acuta*) European, a Bell's Cinixys (*Cinixys belliana*), a Home's Cinixys (*Cinixys homeana*) from West Africa, purchased; a Mute Swan (*Cygnus olor*) European, received in exchange; three Coypus (*Myopotamus coypus*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

SOLAR OBSERVATIONS AT ROME.—In the *Memorie degli Spettroscopisti Italiani* for March, Prof Tacchini communicates the solar observations made at the Royal College. These observations refer to the 4th trimestre of 1892, and are given here somewhat in detail. Taking prominences first, the numbers show a great falling off when compared with the preceding three months; thus for the northern and southern hemispheres the frequency of these phenomena for the three months was 81, 78, 61 for the former (sum 220) and 105, 138, 90, for the latter (sum 333) the foregoing trimestre giving 431 and 493 for each hemisphere. The greatest frequencies took place in latitudes + 60° + 70° N. and − 30° − 40° S., but the numbers indicate really two other maxima for each hemisphere, and they lie in the zones + 30° + 20° and − 50° − 60°.

The frequency of groups of faculæ recorded for both north and south latitudes are given as 100 and 132 respectively; the average for each month amounted to 37, but for the southern zones during October an increase to 20 above this average was noted; the greatest frequencies occurred in zones + 10° + 20° and − 20° − 30°. In dealing with the spots their frequency may be generally stated to be about half that of the faculæ. The table gives 46 and 58 for the two zones, and in this case also the greatest disturbances seem to have occurred in the southern hemisphere during October; the numbers for the monthly records are, for the northern zones 18, 13 and 15, and for the southern 26, 12, and 20, the greatest frequencies occurring in latitudes + 10° + 20° N. and − 20° − 30° S.

Prof. Tacchini, in addition to the above communication, describes in a short note a large protuberance observed on November 20 of last year, and gives 10 figures to illustrate the various forms which it successively assumed. The height and velocity of ascent can be gathered from the few numbers below:—

″		H.	M.
146·3	about	10	57
155·5	,,	11	22·5
188·8	,,	1	21
184·1	,,	1	58
186·4	,,	2	38
154·6	,,	2	52

PARALLAXES OF μ AND θ CASSIOPEIÆ.—In No. 5 of the contributions from the Observatory of Columbia College, New York, Mr. Harold Jacoby presents us with the results he has obtained with regard to the parallaxes of μ and θ Cassiopeiæ, as deduced by him from an examination of the Rutherfurd photographic measures of the stars surrounding μ Cassiopeiæ. The negatives, which were twenty-eight in number, two impressions being on each plate, were made between July, 1870, and December, 1873, and as they were specially taken for parallax determinations, the observations were restricted to the months of July, January, and December. The study of the parallax here made is based upon measures of distance only. Each pair of stars was selected so as to differ approximately 180° in position angle with respect to μ Cassiopeiæ, and the scale value was determined for each pair, on each plate, in order to make the sum of the distances from μ constant. By taking the difference of the same distances as the quantity from the variation of which the parallax should appear, "the excess of the parallax of the principal star over the mean of the parallaxes of the two comparison stars" is, satisfying certain conditions, finally obtained. The values for the parallaxes which he has obtained are—

Parallax of μ Cassiopeiæ	...	$0''\!\cdot\!275 \pm 0''\!\cdot\!024$
,, ,, θ ,,	...	$0\cdot232 \pm 0\cdot067$

On comparing the former of these values with the work of other observatories the discordances, he says, are large. The Oxford photographic result was $0''\!\cdot\!036 \pm 0''\!\cdot\!018$, while the Rutherfurd plates gave $0''\!\cdot\!249 \pm 0''\!\cdot\!045$, the same pair of comparison stars being used in each case. Struve from distant measures deduced the value $0''\!\cdot\!251 \pm 0''\!\cdot\!075$, and from position angles the value $0''\!\cdot\!425 \pm 0''\!\cdot\!072$. "It is therefore plain that the photographic method of determining parallaxes cannot be regarded as free from systematic error."

FALL OF A METEORITE.—A brief account of the fall of a meteorite at a place in South Dakota, 4 km. south of Bath, on August 29 of last year, is given in the current number of *Prometheus*, No. 183. It was observed about four o'clock in the afternoon, attention being first drawn to it by the sound of a series of explosions. As the observer looked upwards he saw a meteoritic stone flying through the air, leaving a trail of smoke behind it. On reaching the ground it plunged to a depth

of 40 cm., and was so hot that the observer was unable to put his hand on it. At the explosion of the meteor several small portions weighing from 30–60 gr. were scattered, while the weight of the chief mass amounted to 22 kg The description of the exterior says that it showed the general, smooth, black crust, while from the fracture it was noticed to be finely granulated; one could also see easily small particles of iron, which could without any difficulty be separated by pulverisation. Chemical analysis showed that nickel and cobalt was present in considerable quantities.

Jahrbuch der Astronomie und Geophysik.—This volume, which is edited by Dr. Hermann J. Klein, contains a very interesting account and summary of the work done in various branches of astronomical science during the past year. Dunér's, Deslandres', Hale's, and Young's sun observations are referred to, while several other references to solar work are given. The numerous observations made with reference to the major and minor planets are here all brought together; Trouvelot's Venus observations, the opposition of Mars, and the recent discovery of Jupiter's fifth satellite being rather prominent. Under the heading of "The Moon" Wernik's enlargements, Boddiker's and Hartmann's researches and are referred to at some length. Comets, meteorites, and shooting stars also come in for a good share, and under the fixed stars, in which are included all variables, nebulæ, &c., are included references to the Nova in Auriga, stellar spectroscopic observations, motion in line of sight, &c.

The Observatory.—From the cover of the *Observatory* one quite misses the familiar name of Dr. Common, in place of which are now inserted Messrs. T. Lewis and H. P. Hollis. In an editorial notice Mr. Turner says a few words to account for this perturbation, mentioning that it is owing to pressure of work, which has made it impossible for either of them to conduct the magazine. He concludes by saying, "It would be with the keenest satisfaction that we should return to the management of the magazine if the future should have that in store for us."

GEOGRAPHICAL NOTES.

The *Scottish Geographical Magazine* for April contains a paper of some value by Colonel Justin C. Ross on irrigation and agriculture in Egypt, giving the result of his experience as Director-General of Irrigation in that country. In consequence of the indisposition of Colonel Bailey the *Magazine* is now edited by Mr. W. A. Taylor, Librarian to the Royal Scottish Geographical Society, who has for several years had charge of the book reviews and geographical notes.

The April number of the *Deutsche Rundschau für Geographie* contains a coloured map of the density of population in Holland which illustrates in a manner very rare in continental map-work an ignorance of the first principles of map colouring. The objects of map-colouring are two—one is to indicate the areas occupied by discontinuous and unlike conditions, such as countries, races of people, or geological formations. For this the colours have to be as strongly contrasted as possible and the map is necessarily and properly a patchwork. The other object is to show the distribution of a continuously varying quantity, like altitude, temperature, or rainfall, and in order to attain it the colours ought to merge one into the other so that the eye is carried from the lowest to the highest value by just perceptible gradations. The Austrian map referred to applies the first method to bring out the second result, each different density of population being coloured so as to contrast with the others, and to show no definite gradation from less to greater.

Globus states that the Russian Government, dissatisfied with the foreign sound of the names Dorpat and Dünaburg, have resolved to rename those towns Jurjew and Dwinsk respectively.

The Paris Geographical Society held a special meeting in commemoration of the discoveries of Columbus on March 4, the four hundredth anniversary of his return from the first transatlantic voyage. A masterly address by M. Levasseur on the moral and material consequences of the discovery of America, and a paper by Dr. Hamy on the traces of Columbus in Spain and Italy were the principal features of the meeting.

Some recent measurements in Russia, noticed by M. Venukoff in the last number of the *Comptes Rendus* are valuable as leading to some conclusions regarding the form of the geoid. Determinations of the value of the degree of longitude along the parallels of 47°30′ and 52° accord closely with Bessel's geoid (polar flattening $\frac{1}{299}$) and are widely divergent from Clarke's result of $\frac{1}{293}$.

THE AMIDE AND IMIDE OF SULPHURIC ACID.

Further details concerning these interesting substances are communicated by Dr. Traube of the laboratory of the Berlin University to the current number of the *Berichte*. It has long been surmised that an amide of sulphuric acid was capable of existence, and Regnault assumed that the product which he obtained by leading ammonia gas into a solution of sulphuryl dichloride in ethylene chloride consisted of that substance mixed with sal-ammoniac. Dr. Traube has further investigated the reaction and has at length isolated not only sulphuryl diamide, $SO_2(NH_2)_2$, but also sulphuryl imide, SO_2NH, the imide of sulphuric acid, and has, moreover, prepared several metallic derivatives of each.

Sulphuryl Diamide.

The most advantageous mode of preparing sulphuryl diamide consists in saturating a solution of sulphuryl dichloride, SO_2Cl_2, in chloroform with ammonia. It is necessary to dilute the sulphuryl dichloride with 15–20 times its volume of chloroform, and to maintain a low temperature by extraneous cooling in order that the reaction may be under complete control, and the ammonia gas must be carefully dried before being allowed to bubble through the liquid. The main reaction occurs in accordance with the following equation:—

$$SO_2Cl_2 + 4NH_3 = 2NH_4Cl + SO_2(NH_2)_2.$$

The products are gradually deposited in the form of a white solid, which, after the completion of the reaction, is agitated with water until the whole of it is dissolved. The ammoniacal aqueous solution is then separated from the chloroform, acidified with nitric acid, and the whole of the chlorine removed by the addition of silver nitrate. After removal of the silver chloride by filtration the acid solution is neutralised with alkali and silver nitrate again added, when a crystalline precipitate is obtained consisting of a silver derivative of sulphuryl diamide, $SO_2(NHAg)_2$, together with another silver compound, whose composition has not yet been definitely ascertained. In order to isolate the silver compound of sulphuryl diamide, the washed precipitate is decomposed with the calculated quantity of hydrochloric acid, and the resulting acid liquid carefully neutralised with ammonia; upon now adding silver nitrate only the silver compound of unknown and complex composition is deposited. The pure silver compound of sulphuryl diamide is finally deposited upon adding a further quantity of silver nitrate and sufficient ammonia to render the liquid strongly alkaline.

When the precipitated silver compound of sulphuryl diamide is decomposed with hydrochloric acid a feebly acid liquid is obtained, which, when evaporated to a syrup *in vacuo*, at a temperature not exceeding 40°, and afterwards allowed to stand *in vacuo* over oil of vitriol, gradually deposits large colourless crystals of pure sulphuryl diamide, $SO_2(NH_2)_2$.

Sulphuryl diamide is an extremely deliquescent substance. The crystals are rapidly dissolved by water, but are practically insoluble in organic solvents. They soften at 75° and melt at 81°. As the liquid cools, however, it exhibits the property of superfusion to a very marked extent, remaining liquid many degrees below its melting-point. The moment, however, it is disturbed by contact with a sharp body, it instantly solidifies. When heated above its melting-point sulphuryl diamide loses ammonia even below 100°; up to 250° no further decomposition than the loss of ammonia occurs, the residual compound being the sulphuryl imide to be presently described. Above 250° complete decomposition ensues with the evolution of acid fumes.

The aqueous solution of sulphuryl diamide reacts neutral to litmus and possesses a bitter taste. It yields no precipitates in acid solutions either with salts of barium or platinic chloride. On long boiling with acids, however, it is gradually converted into sulphuric acid and ammonia, and then yields the usual

precipitates for those substances with barium or platinic chloride. Its behaviour with nitrous acid is interesting. Upon adding to an acid solution of sulphuryl diamide a few drops of the solution of a nitrite nitrogen is at once evolved, in the cold, and sulphuric acid is formed.

Sulphuryl diamide does not combine with acids. Alkalies appear to be only capable of removing one amido group, converting the diamide into sulphaminic acid, $SO_2(NH_2)(OH)$.

As described in the course of the preparation of sulphuryl diamide, ammonia precipitates from a solution mixed with silver nitrate a silver compound. If the precipitate is allowed to remain in contact with the excess of the reagents for some time, it invariably yields numbers upon analysis which agree with the formula $SO_2(NHAg)_2$. If, however, it is at once separated, it is found to consist of a mixture of this salt with the salt $SO_2(NH_2)(NHAg)$.

These silver compounds of sulphuryl diamide are amorphous, even after deposition from solution in hot water. When dry they are white powders very slightly sensitive to light. Upon heating to 200° they decompose with evolution of sulphur dioxide.

Sulphuryl diamide likewise forms a compound with mercuric oxide when its solution is mixed with one of mercuric nitrate. The composition of this precipitate, however, appears to vary with the degree of concentration of the solutions employed, and if chlorides are present a precipitate is only obtained with a very large excess of mercuric nitrate. Mercuric chloride produces no precipitate at all.

A somewhat similar lead compound is also formed when lead acetate is added to a moderately concentrated solution of sulphuryl diamide.

Sulphuryl Imide.

As previously mentioned, when sulphuryl diamide is heated for a considerable time above its melting-point it loses ammonia and becomes converted into sulphuryl imide:

$$SO_2(NH_2)_2 = NH_3 + SO_2NH.$$

The best temperature for the rapid production of sulphuryl imide is 200°-210°. The evolution of ammonia at this temperature is very vigorous, occurring with much frothing, but after a time diminishes and finally ceases, the mass becoming eventually solid. To purify it from impurities the solution in water is treated with a solution of silver nitrate when the silver compound of sulphuryl imide, SO_2NAg, is precipitated, and may be recrystallised in long acicular crystals, first from water slightly acidified with nitric acid, and finally from pure water.

Upon decomposing the silver compound with the calculated quantity of dilute hydrochloric acid an aqueous solution of free sulphuryl imide is obtained, which reacts strongly acid, and liberates carbon dioxide from carbonates. Upon evaporation, however, it decomposes, and deposits hydrogen ammonium sulphate. Even evaporation *in vacuo* is sufficient to decompose it, so that crystals of the imide itself have not been obtained. It exists, however, in the solid form, although somewhat contaminated with smaller quantities of other products, in the residue obtained by heating sulphuryl diamide as previously described.

Salts of sulphuryl imide, however, are readily obtained, either by decomposition of the silver salt with metallic chlorides, or by the neutralisation of solutions of sulphuryl imide with metallic oxides or carbonates.

The potassium salt, SO_2NK, was obtained in the form of well-developed colourless crystals by adding a quantity of the silver salt to a hot solution of the calculated quantity of potassium chloride, removing the precipitated silver chloride by filtration, and evaporating the solution. Both the solution and the salt are very stable; it requires long boiling with acids to convert it into sulphuric acid. When the dry salt is heated it decomposes with considerable violence and production of flame. Nitrogen and sulphur dioxide escape, and potassium sulphate and sulphite are left.

The sodium salt, SO_2NNa, obtained by neutralising a solution of sulphuryl imide with caustic soda and subsequent evaporation, forms small crystals, which decompose upon heating in a manner similar to the crystals of the potassium salt.

The ammonium salt, SO_2NNH_4, isomeric with sulphuryl diamide, was likewise obtained in colourless needles by neutralisation of the free imide with ammonia. It is interesting to note that this substance is not capable of being converted into its isomer by repeated crystallisation, but is partially so converted by rapidly heating it to its melting-point over a small gas flame.

Acicular crystals of a hydrated barium salt, $(SO_2N)_2Ba.2H_2O$, have been obtained by saturating a solution of the imide with barium carbonate and afterwards adding alcohol; also needles of a lead salt and a green amorphous copper salt.

The acid character of sulphuryl imide, so different from the neutral nature of sulphuryl diamide, is thus seen to be quite conclusively established. A. E. TUTTON.

THE DENSITIES OF THE PRINCIPAL GASES.[1]

IN former communications ("Roy. Soc. Proc.," February, 1888; February, 1892) I have described the arrangements by which I determined the ratio of densities of oxygen and hydrogen (15·882). For the purpose of that work it was not necessary to know with precision the actual volume of gas weighed, nor even the pressure at which the containing vessel was filled. But I was desirous before leaving the subject of ascertaining not merely the relative, but also the absolute, densities of the more important gases—that is, of comparing their weights with that of an equal volume of water: To effect this it was necessary to weigh the globe used to contain the gases when charged with water, an operation not quite so simple as at first sight it appears. And, further, in the corresponding work upon the gases, a precise absolute specification is required of the temperature and pressure at which a filling takes place. To render the former weighings available for this purpose, it would be necessary to determine the errors of the barometers then employed. There would, perhaps, be no great difficulty in doing this, but I was of opinion that it would be an improvement to use a manometer in direct connection with the globe, without the intervention of the atmosphere. With respect to temperature, also, it was thought better to avoid all further questions by surrounding the globe with ice, as in Regnault's original determinations.

The Manometer.

The arrangements adopted for the measurement of pressure must be described in some detail, as they offer several points of novelty.

The object in view was to avoid certain defects to which ordinary barometers are liable, when applied to absolute measurements. Of these three especially may be formulated:—

(*a*) It is difficult to be sure that the vacuum at the top of the mercury is suitable for the purpose.

(*b*) No measurements of a length can be regarded as satisfactory in which different methods of reading are used for the two extremities.

(*c*) There is necessarily some uncertainty due to irregular refraction by the walls of the tube. The apparent level of the mercury may deviate from the real position.

(*d*) To the above may be added that the accurate observation of the barometer, as used by Regnault and most of his successors, requires the use of a cathetometer, an expensive and not always satisfactory instrument.

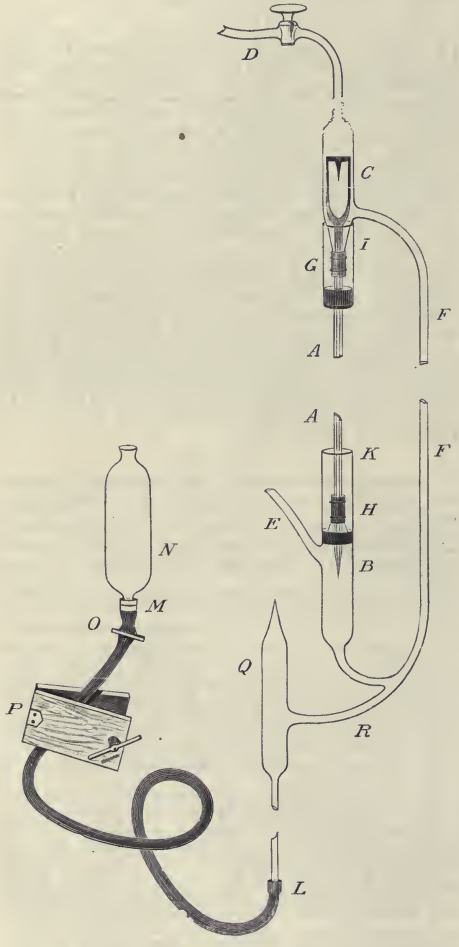
The guiding idea of the present apparatus is the actual application of a measuring rod to the upper and lower mercury surfaces, arranged so as to be vertically superposed. The rod AA, fig. 1, is of iron (7 mm. in diameter), pointed below B. At the upper end, C, it divides at the level of the mercury into a sort of fork, and terminates in a point similar to that at B, and, like it, directed downwards. The coincidence of these points with their images reflected in the mercury surfaces, is observed with the aid of lenses of about 30 mm. focus, held in position upon the wooden framework of the apparatus. It is, of course, independent of any irregular refraction which the tube may exercise. The verticality of the line joining the points is tested without difficulty by a plumb-line.

The upper and lower chambers C, B are formed from tubing of the same diameter (about 21 mm. internal). The upper communicates through a tap, D, with the Töppler, by means of which a suitable vacuum can at any time be established and tested. In ordinary use, D stands permanently open, but its

[1] Abstract of a paper read by Lord Rayleigh before the Royal Society on March 23.

introduction was found useful in the preliminary arrangements and in testing for leaks. The connection between the lower chamber B and the vessel in which the pressure is to be verified takes place through a side tube, E.

The greater part of the column of mercury to which the pressure is due is contained in the connecting tube FF, of about 3 mm. internal diameter. The temperature is taken by a thermometer whose bulb is situated near the middle of FF. Towards the close of operations the more sensitive parts are protected by a packing of tow or cotton-wool, held in position between two wooden boards. The anterior board is provided



with a suitable glass window, through which the thermometer may be read.

It is an essential requirement of a manometer on the present plan that the measuring rod pass air-tight from the upper and lower chambers into the atmosphere. To effect this the glass tubing is drawn out until its internal diameter is not much greater than that of the rod. The joints are then made by short lengths of thick walled india-rubber H, G, wired on and drowned externally in mercury. The vessels for holding the mercury are shown at I, K.

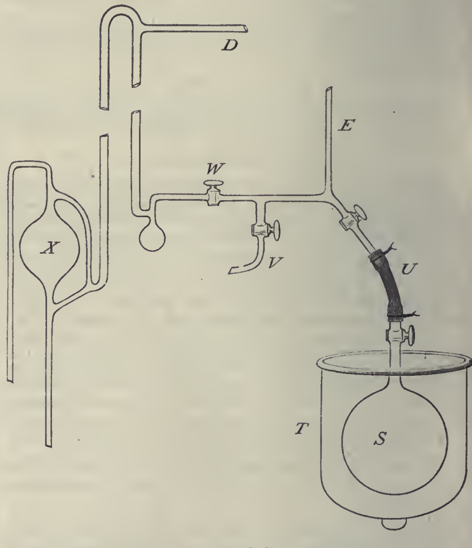
The distance between the points of the rod is determined under microscopes by comparison with a standard scale, before the apparatus is put together. As the rod is held only by the rubber connexions, there is no fear of its length being altered by stress.

The adjustment of the mercury (distilled in a vacuum) to the right level is effected by means of the tube of black rubber LM, terminating in the reservoir N. When the supply of mercury to the manometer is a little short of what is needed, the connexion with the reservoir is cut off by a pinch-cock at O, and the fine adjustment is continued by squeezing the tube at P between a pair of hinged boards, gradually approximated by a screw. This plan, though apparently rough, worked perfectly, leaving nothing to be desired.

It remains to explain the object of the vessel shown at Q. In the early trials, when the rubber tube was connected directly to R, the gradual fouling of the mercury surface, which it seems impossible to avoid, threatened to interfere with the setting at B. By means of Q, the mercury can be discharged from the measuring chambers, and a fresh surface constituted at B as well as at C.

Connexions with Pump and Manometer.

Some of the details of the process of filling the globe with gas under standard conditions will be best described later under the head of the particular gas; but the general arrangement and



the connexions with the pump and the manometer are common to all. They are sketched in Fig. 2, in which S represents the globe, T the inverted bell-glass employed to contain the enveloping ice. The connexion with the rest of the apparatus is by a short tube U of thick rubber, carefully wired on. The tightness of these joints was always tested with the aid of the Töppler X, the tap V leading to the gas generating apparatus being closed. The side tube at D leads to the vacuum chamber of the manometer, while that at E leads to the pressure chamber B. The wash out of the tubes, and in some cases of the generator, was aided by the Töppler. When this operation was judged to be complete, V was again closed, and a good vacuum made in the parts still connected to the pump. W would then be closed, and the actual filling commenced by opening V, and finally the tap of the globe. The lower chamber of the manometer was now in connexion with the globe, and through a regulating tap (not shown) with the gas-generating apparatus. By means of the Töppler, the vacuum in the manometer could be carried to any desired point. But with respect to this a remark must be made. It is a feature of the method employed[1] that the exhaustions of

[1] Due to von Jolly.

the globe are carried to such a point that the weight of the residual gas may be neglected, thus eliminating errors due to a second manometer reading. There is no difficulty in attaining this result, but the delicacy of the Töppler employed as a gauge is so great that the residual gas still admits of tolerably accurate measurement. Now in exhausting the head of the manometer it would be easy to carry the process to a point much in excess of what is necessary in the case of the globe, but there is evidently no advantage in so doing. The best results will be obtained by carrying both exhaustions to the *same* degree of perfection.

The Water Contents of the Globe.

The globe being packed in finely-divided ice, was filled with boiled distilled water up to the level of the top of the channel through the plug of the tap, that is, being itself at 0°, was filled with water also at 0°. Thus charged the globe had now to be weighed; but this was a matter of some difficulty, owing to the very small capacity available above the tap. At about 9° there would be a risk of overflow. Of course the water could be retained by the addition of extra tubing, but this was a complication that it was desired to avoid. In February, 1882, during a frost, an opportunity was found to effect the weighing in a cold cellar at a temperature ranging from 4° to 7°. The weights required (on the same side of the balance as the globe and its supports) amounted to 0·1822 gram. On the other side were other weights whose values did not require to be known so long as they remained unmoved during the whole series of operations. Barometer (corrected) 758·9 mm.; temperature 6°·3.

A few days later the globe was discharged, dried, and replaced in the balance with tap open. 1834·1701 grams had now to be associated with it in order to obtain equilibrium. The difference,

$$1834{\cdot}170 - 0{\cdot}182 = 1833{\cdot}988,$$

represents the weight of the water less that of the air displaced by it.

It remains to estimate the actual weight of the air displaced by the water under the above mentioned atmospheric conditions. It appears that, on this account, we are to add 2·314, thus obtaining

$$1836{\cdot}30$$

as the weight of the water at 0° which fills the globe at 0°.

A further small correction is required to take account of the fact that the usual standard density is that of water at 4° and not at 0°. According to Broch (Everett's "C.G.S. System of Units"), the factor required is 0·99988, so that we have

$$\frac{1836{\cdot}30}{0{\cdot}99988} = 1836{\cdot}52$$

as the weight of water at 4° which would fill the globe at 0°.

Air.

Air drawn from outside (in the country) was passed through a solution of potash. On leaving the regulating tap it traversed tubes filled with fragments of potash, and a long length of phosphoric anhydride, followed by a filter of glass wool. The arrangements beyond the regulating tap were the same for all the gases experimented upon.

In deducing the weight of the gas we compare each weighing "full" with the mean of the preceding and following weights "empty," except in the case of October 15, when there was no subsequent weighing empty. The results are

September	27	2·37686
,,	29	2·37651
October	3	2·37653
,,	8	2·37646
,,	11	2·37668
,,	13	2·37679
,,	15	2·37647
	Mean	2·37661

There is here no evidence of the variation in the density of air suspected by Regnault and v. Jolly.

To allow for the contraction of the globe (No. 14) when weighed empty, discussed in my former papers, we are to add 0·00056 to the apparent weight, so that the result for air becomes

$$2{\cdot}37717.$$

This is the weight of the contents at 0° and under the pressure defined by the manometer gauge at 15° of the thermometer. The reduction to standard conditions is, for the present, postponed.

Oxygen.

This gas has been prepared by three distinct methods: (*a*) from chlorates, (*b*) from permanganate of potash, (*c*) by electrolysis.

In the first method mixed chlorates of potash and soda were employed, as recommended by Shenstone, the advantage lying in the readier fusibility. Two sets of five fillings were effected with this oxygen. In the first set (May, 1892) the highest result was 2·6272, and the lowest 2·6266, mean 2·62691. In the second set (June, July, 1892) the highest result was 2·6273 and the lowest 2·6267, mean 2·62693.

The second method (*b*) proved very convenient, the evolution of gas being under much better control than in the case of chlorates. The recrystallised salt was heated in a Florence flask, the wash-out, in this case also, being facilitated by a vacuum. Three fillings gave satisfactory results, the highest being 2·6273, the lowest 2·6270, and the mean 2·62714. The gas was quite free from smell.

By the third method I have not as many results as I could have wished, operations having been interrupted by the breakage of the electrolytic generator. This was, however, of less importance, as I had evidence from former work that there is no material difference between the oxygen from chlorates and that obtained by electrolysis. The gas was passed over hot copper, as detailed in previous papers. The result of one filling, with the apparatus as here described, was 2·6271. To this may be added the result of two fillings obtained at an earlier stage of the work, when the head of the manometer was exhausted by an independent Sprengel pump, instead of by the Töppler. The value then obtained was 2·6272. The results stand thus:—

Electrolysis (2), May, 1892	2·6272
,, (1) ,, ...	2·6271
Chlorates (5), May, 1892	2·6269
,, (5), June, 1892	2·6269
Permanganate (3), January, 1893 ...	2·6271
Mean	2·62704
Correction for contraction ...	0·00056
	2·62760

It will be seen that the agreement between the different methods is very good, the differences, such as they are, having all the appearance of being accidental. Oxygen prepared by electrolysis is perhaps most in danger of being light (from contamination with hydrogen), and that from chlorates of being abnormally heavy.

Nitrogen.

This gas was prepared, in the usual manner, from air by removal of oxygen with heated copper. Precautions are required, in the first place, to secure a sufficient action of the reduced copper, and secondly, as was shown by v. Jolly, and later by Leduc, to avoid contamination with hydrogen which may be liberated from the copper. I have followed the plan, recommended by v. Jolly, of causing the gas to pass finally over a length of unreduced copper. The arrangements were as follows:—

Air drawn through solution of potash was deprived of its oxygen by reduced copper, contained in a tube of hard glass heated by a large flame. It then traversed a U-tube, in which was deposited most of the water of combustion. The gas, practically free, as the event proved, from oxygen, was passed, as a further precaution, over a length of copper heated in a combustion furnace, then through strong sulphuric acid,[1] and afterwards back through the furnace over a length of oxide of copper. It then passed on to the regulating tap, and thence through the remainder of the apparatus, as already described. In no case

[1] There was no need for this, but the acid was in position for another purpose.

did the copper in the furnace, even at the end where the gas entered, show any sign of losing its metallic appearance.

Three results, obtained in August, 1892, were :—

August 8	2·31035
,, 10	2·31026
,, 15	2·31024
Mean	2·31028

To these may be added the results of two special experiments made to test the removal of hydrogen by the copper oxide. For this purpose a small hydrogen generator, which could be set in action by closing an external contact, was included between the two tubes of reduced copper, the gas being caused to bubble through the electrolytic liquid. The quantity of hydrogen liberated was calculated from the deflection of a galvanometer included in the circuit, and was sufficient, if retained, to alter the density very materially. Care was taken that the small stream of hydrogen should be uniform during the whole time (about $2\frac{1}{2}$ hours) occupied by the filling, but, as will be seen, the impurity was effectually removed by the copper oxide.[1] Two experiments gave—

September 17	2·31012
,, 20	2·31027
Mean	2·31020

We may take as the number for nitrogen—

	2·31026
Correction for contraction	56
	2·31082

Although the subject is not yet ripe for discussion, I cannot omit to notice here that nitrogen prepared from ammonia, and expected to be pure, turned out to be decidedly lighter than the above. When the oxygen of air is burned by excess of ammonia, the deficiency is about 1/1000th part.[2] When oxygen is substituted for air, so that all (instead of about one-seventh part) of the nitrogen is derived from ammonia, the deficiency of weight may amount to $\frac{1}{2}$ per cent. It seems certain that the abnormal lightness cannot be explained by contamination with hydrogen, or with ammonia, or with water, and everything suggests that the explanation is to be sought in a dissociated state of the nitrogen itself. Until the questions arising out of these observations are thoroughly cleared up, the above number for nitrogen must be received with a certain reserve. But it has not been thought necessary, on this account, to delay the presentation of the present paper, more especially as the method employed in preparing the nitrogen for which the results are recorded is that used by previous experimenters.

Reduction to Standard Pressure.

The pressure to which the numbers so far given relate is that due to 762·511 mm. of mercury at a temperature of 14°·85,[3] and under the gravity operative in my laboratory in latitude 51° 47'. In order to compare the results with those of other experimenters, it will be convenient to reduce them not only to 760 mm. of mercury pressure at 0°, but also to the value of gravity at Paris.

The product of the three factors, corrective for length, for temperature, and for gravity, is 0·99914. Thus multiplied, the numbers are as follows :—

Air.	Oxygen.	Nitrogen.
2·37512	2·62534	2·30883

and these may now be compared with the water contents of the globe, viz. 1836·52.

The densities of the various gases under standard conditions, referred to that of distilled water at 4°, are thus :—

Air.	Oxygen.	Nitrogen.
0·00129327	0·00142952	0·00125718

With regard to hydrogen, we may calculate its density by means of the ratio of densities of oxygen and hydrogen formerly given by me, viz. 15·882. Hence

Hydrogen.
0·000090009.

The following table shows the results arrived at by various experimenters. Von Jolly did not examine hydrogen. The numbers are multiplied by 1000 so as to exhibit the weights in grams per litre :—

	Air.	Oxygen.	Nitrogen.	Hydrogen.
Regnault, 1847	1·29319	1·42980	1·25617	0·08958
Corrected by Crafts	1·29349	1·43011	1·25647	0·08988
Von Jolly, 1880	1·29351	1·42939	1·25787	—
Ditto corrected	1·29383	1·42971	1·25819	—
Leduc, 1891[1]	1·29330	1·42910	1·25709	0·08985
Rayleigh, 1893	1·29327	1·42952	1·25718	0·09001

The correction of Regnault by Crafts (*Comptes Rendus*, vol. cvi., p. 1664) represents allowance for the contraction of Regnault's globe when exhausted, but the data were not obtained from the identical globe used by Regnault. In the fourth row I have introduced a similar correction to the results of von Jolly. This is merely an estimate founded upon the probability that the proportional contraction would be about the same as in my own case and in that of M. Leduc.

In taking a mean we may omit the uncorrected numbers, and also that obtained by Regnault for nitrogen, as there is reason to suppose that his gas was contaminated with hydrogen. Thus

Mean Numbers.

Air.	Oxygen.	Nitrogen.	Hydrogen.
1·29347	1·42961	1·25749	0·08991

The evaluation of the densities as compared with water is exposed to many sources of error which do not affect the comparison of one gas with another. It may, therefore, be instructive to exhibit the results of various workers referred to air as unity.

	Oxygen.	Nitrogen.	Hydrogen.
Regnault (corrected)	1·10562	0·97138	0·06949
v. Jolly (corrected)	1·10502	0·97245	—
Leduc	1·1050	0·9720	0·06947
Rayleigh	1·10535	0·97209	0·06960
Mean	1·10525	0·97218	0·06952

As usually happens in such cases, the concordance of the numbers obtained by various experimenters is not so good as might be expected from the work of each taken separately. The most serious discrepancy is in the difficult case of hydrogen. M. Leduc suggests (*Comptes Rendus*, July, 1892) that my number is too high on account of penetration of air through the blow-off tube (used to establish equilibrium of pressure with the atmosphere), which he reckons at 1 m. long and 1 cm. in diameter. In reality the length was about double, and the diameter one-half of these estimates; and the explanation is difficult to maintain, in view of the fact, recorded in my paper, that a prolongation of the time of contact from 4m to 30m had no appreciable ill effect. It must be admitted, however, that there is a certain presumption in favour of a lower number, unless it can be explained as due to an insufficient estimate for the correction for contraction. On account of the doubt as to the appropriate value of this correction, no great weight can be assigned to Regnault's number for hydrogen. If the atomic weight of oxygen be indeed 15·88, and the ratio of densities of oxygen and hydrogen be 15·90, as M. Leduc makes them, we should have to accept a much higher number for the ratio of volumes than that (2·0002) resulting from the very elaborate measurements of Morley. But while I write the information reaches me that Mr. A. Scott's recent work upon the volume ratio leads him to just such a higher ratio, viz. 2·00245, a number *a priori* more probable than 2·0002. Under the circumstances both the volume ratio and the density of hydrogen must be regarded as still uncertain to the 1/1000th part.

[1] Much larger quantities of hydrogen, sufficient to reduce the oxide over several centimetres, have been introduced without appreciably altering the weight of the gas.

[2] NATURE, vol. xlvi. p. 512.

[3] The thermometer employed with the manometer read 0°·15 too high.

[1] *Bulletin des Séances de la Société de Physique.*

ELECTRICAL RAILWAYS.[1]

ONE of the most striking of the many new departures in the practical application of electrical science, which made the Paris Exhibition of 1881 memorable, was a short tramway laid

[1] Friday evening discourse delivered at the Royal Institution by Dr. Edward Hopkinson on February 24.

down, under the direction of the late Sir William Siemens, from the Palais de l'Industrie to the Place de la Concorde, upon which a tramcar worked by an electric motor plied up and down with great regularity and success during the period of the Exhibition. Yet few of those who saw in this experiment the possibilities of a great future for a new mode of traction would have ventured to predict that within ten years' time, in the United States alone, over 5,000 electric cars would be in operation, travelling 50,000,000 miles annually, and carrying 250,000,000 passengers, or that electrical traction would have solved the problem of better communication in London and other large cities. Two years before the exhibition in Paris the late Dr. Werner Siemens had exhibited at the Berlin Exhibition in 1879 an experimental electric tramway on a much smaller scale, and his firm had put down in 1881 the first permanent electric railway in the short length of line at Lichterfelde, near Berlin, which, I believe, is still at work. In the same year Dr. William Siemens undertook to work the tramway, then projected, between Portrush and Bushmills, in the north of Ireland, over six miles in length, by electric power, making use of the water power of the Bush River for the purpose, an undertaking which I had the advantage of carrying out under his direction. It is no part of my object to-night to follow further the history of electric traction, which is so recent that it is familiar to all; but, in alluding to these initial stages of its development, I have desired to recall that it was to the foresight and energy of Dr. Werner and Dr. William Siemens, and their skill in applying scientific knowledge to the uses of daily life, which gave the first impulse to the development of the new electrical power.

The problem of electric traction may be naturally considered under three heads:—

(1) The production of the electrical power.

(2) Its distribution along the line.

(3) The reconversion of electrical into mechanical power, in the car motor or locomotive.

The first of these here in England at any rate is dependent upon the economical production of steam power, although there are essential points of difference between the conditions under which steam power is required for electric traction purposes and for electric lighting. But in Scotland and Ireland and in many countries abroad there is abundant water power, now only very partially utilised. The Portrush line is worked in part by water and in part by steam power, but in the Bessbrook and Newry Tramway (of which there is a working model on the table) water power is exclusively used.

A few experiments will show that the demand for power on the generating plant is greatest at the moment of starting the car or train, when in addition to the power required to overcome the frictional resistances power is also required to accelerate the velocity. Thus, if instead of a single car there are a number of trains moving on the one system, and it so happens that several are starting together, the demand made upon the generating plant may at one moment be three or four times as great as that made a few seconds after. This is shown in the diagrams which exhibit the variation of current supplied by the generators on the City and South London Railway, with eight trains running together, the readings being taken every ten seconds. The maxima rise as high as double the mean; thus the generating plant must be capable of instantly responding to a demand double or even treble the average demand upon it.

In electric lighting it is true there is not less variation between the maximum demand and the mean taken during the ordinary hours of lighting, but it is only in the event of sudden fog that the probable demand cannot be accurately gauged beforehand, and provided for by throwing more generators into action. Thus in a lighting station each generator may be kept working approximately at its full load, and therefore under conditions of maximum economy, whereas in a traction station the whole plant must be kept ready to instantaneously respond to the maximum demands which may be made upon it, and must therefore necessarily work with a low load factor, and consequently with diminished economy. So important is the influence on cost of production of the possible demand in relation to average demand, that the Corporation of Manchester under their order for electric supply, have decided upon the advice of their engineer to annually charge a customer £3 per quarter for each unit per hour of maximum supply which he may require, in addition to 2*d.* per unit for each unit actually consumed, *i.e.* for being ready to supply him with a certain amount of electrical power if required to do so, they charge an additional sum equivalent to the charge for its actual consumption for 1440 hours.

In one respect water power has an economic advantage over steam power, because although steam engine and turbine alike work with greatly reduced efficiency at reduced loads, when the turbine gates are partially closed and the water restrained in the reservoir, it is not subject to loss of potential energy, whereas the energy of the steam held back by the valves of the engine suffers loss through radiation and condensation.

At Bessbrook the turbine and generator dynamo combined yield 60 per cent. of the energy of the water as electrical energy available for work on the line, but when the load is reduced to a third of the full load the efficiency is reduced to 33 per cent. So on the City and South London line a generator engine and dynamo will yield, when working at their full load, 78 per cent. of the indicated horse-power as useful electrical power, but at half load the efficiency falls to 65 per cent. Notwithstanding these conditions the generator station of the City and South London line is producing electrical energy at a cost of 1·56*d.* per Board of Trade unit, which is less than the annual average cost of production of any electric station in England, with the single exception of Bradford, which has the advantage both of cheap coal and cheap labour. In output it is the largest of any Electric Generating Station in England, the total electrical energy delivered in 1892 being 1,250,000 Board of Trade units, the second on the list being the St. James and Pall Mall with 1,186,826 units.

Let us pass now to the consideration of the distribution of the electric power along the line. I have equipped the three model tracks before you with three different kinds of conductors. In two of them the rails of the permanent way, which are necessarily uninsulated, are made use of for the return current. This plan, with I believe the almost single exception of the Buda Pesth Tramway, has been universally adopted with the object of saving the cost of a return conductor; but it is doubtful whether such an arrangement can be considered final, for it must necessarily create differences of potential in the earth, which already in some instances have had disturbing effects upon our observatories, or upon our telegraph and telephone systems. It appears to be probable in the more or less distant future that the use of the earth for the passage of large current will be guarded by legislation; and that it will be reserved for the more delicate and widely extended operations of telegraphy and telephony. These disturbances may of course be easily avoided by the use of an insulated conductor for the return circuit. In the case of conductors which are in such a position that contact may be made from them to the ground through the body of a horse or some other animal coming into contact with them, there is another strong argument for an insulated return, as many animals, and notably horses, are far more sensitive to electric shock than man. It is not perhaps well known, but still a fact, that a shock of 250 volts is quite sufficient to kill a horse almost instantaneously.

The first model has a single overhead conductor with return by the rails; but in place of a single fishing-rod collector or trolley to take the current from the overhead wire there are fixed on the car two rigid bars, one at each end, which slide along the under surface of the wire and make a rubbing contact against it. This system, devised by Dr. John Hopkinson, has the advantage that there is less difficulty in maintaining contact on uneven roads or on curves, and that the catenaries of the suspended wire may be hung with greater dip, and therefore with less tension. Again, the double contact obviates the frequent breaks and consequent sparking of a single trolley system. The second model shows the system adopted on the City and South London line, and more recently followed on the Liverpool Overhead line, of a conductor of channel steel, upon which collectors fixed to the locomotives make a sliding contact. The third track shows an overhead system like the first, but with an insulated return in place of return by the rails.

The characteristic feature of an electric motor is that it delivers us the mechanical power we require directly in the form of a couple about an axis instead of in the form of a rectilinear force, as is the case with steam, gas, or air engines, which must be reduced to a rotary form by connecting rod and crank. Thus it is possible to sweep away all intermediate gear, and to arrive at once at the simplest of all forms of a traction motor, consisting of but one pair of wheels fixed on a single axle with the armature constructed directly upon it, with its magnets suspended from it and maintained in their position against the

magnetic forces acting upon them by their weight. Such a locomotive is shown in the third model before you. So far as I am aware, a locomotive of such simplicity as this has never been constructed for practical work, but on the City and South London line the armatures of the motors are placed directly on the axles and the magnets, suspended partly from the axles and partly from the frame.

The second model is an exact reproduction of the locomotives on the City and South London line, but with a different arrangement of motors. Here both armatures are included in the same magnetic circuit, and both magnets and armatures carried on the frame of the locomotive and not on the axles. The armatures are geared to the axles by diagonal connecting rods, the axle boxes being inclined, so that their rise and fall in the horn blocks is at right angles to the connecting rods. This design, which is due to the late Mr. Lange, of Messrs. Beyer, Peacock & Co., allows of the motor armature being placed on the floor level of the locomotive, and so more easily accessible.

This model will serve to show some of the characteristic features as well as some of the characteristic defects of an electric motor as such. But in order to show these clearly I may refer for a moment to the general theory of a motor. It is easily shown that in a series wound motor the couple or turning moment on the axle is a function of the current only, and independent of the speed and electro-motive force. Again it follows from Ohm's law that the current passing through the motor multiplied by the resistance of the magnet and armature coils is equal to the difference between the electro-motive force at the terminals of the motor and the electro-motive force which would be generated by the motor, if it were working at the same speed as a generator of electricity, that is to say the difference between the electro-motive force at the terminals and what is called the "back" or "counter" electro-motive force of the motor. Hence if the terminals of the motor be coupled direct to the line at the moment of starting when the motor is still at rest, the current will be very great and its power entirely absorbed in the coils of the armature and magnets, but the turning moment will then be a maximum. The motor then begins to move, part of the power being spent in overcoming frictional resistances and part in accelerating the train. A back electro-motive force is then set up, increasing as the speed increases, and causing the current to diminish until finally a position of equilibrium is established, when the speed is such that the back electro-motive force together with the loss of potential in the coils of the motor is equal to the potential of the line. But in practice the mechanical strength of the motor, and the carrying power of its coils, as well as the limited current available from the generators makes it necessary to introduce resistances in circuit with the motor to throttle the current and to reduce it within proper limits. It is to this point I desire to draw attention, that in traction work when starting the motor resistances must be introduced, which, with the resistance of the motor itself, at the moment of starting, absorb the whole power of the current, reducing the efficiency of the motor to nil, and which continue to absorb a large percentage of the power, until the condition of equilibrium is established. This is the great defect in electric motors for traction work, and its importance can be shown very clearly by reference to the work done on the City and South London line. There the motors when working with their normal current have an efficiency of 90 per cent., but the actual all-round efficiency of the locomotives as a whole is 70 per cent. only, so that the loss in starting is equal to 20 per cent. of the whole power. Of course in some respects the City and South London line is exceptional in that a start is made every two or three minutes. Various devices have been suggested with a view to diminishing this waste of power in starting an electric motor, but none entirely meet the case. Thus if the locomotive or car has two motors, these can be coupled in series at the start, and subsequently thrown into parallel, thereby doubling the tractive force with a given current, or for the same tractive force reducing the loss of power by three-fourths. When through the increase of speed of the motor the back electro-motive force balances the electro-motive force of the line the speed can be increased by diminishing the magnetic field by reducing the effective coils on the magnets, but this device does not give any assistance at the lower speeds, as the magnets ought to be so wound as to be high on the characteristic curve, or nearly saturated, with the normal current, and it is therefore not possible to obtain any increased intensity of field, by increasing the convolutions of the magnet coils. If it were possible to use alternate current motors for traction work the difficulty could at once be met by introducing a transformer in the circuit, and placing the motor in its secondary. The effective convolutions of the secondary circuit on the transformer could then be varied as the speed increases in such wise that the electro-motive force of the line is balanced by the back electro-motive force of the motor and the fall of potential due to the resistance of the motor coils, so avoiding all need for resistances.

The City and South London line has enabled experiments to be made on the efficiency of the railway system as a whole, taking into account the loss of power in the generators, on the line, and in the motors, and in the resistances of the locomotives. The loss in the line is about eleven per cent. of the power generated, and the efficiency of the locomotives as a whole is, as I have shown, 70 per cent.; thus the electrical efficiency of the entire system is 62 per cent. The trains weigh with full load of 100 passengers about forty tons, and the average speed between stations is 13·5 miles per hour. The cost of working, including all charges, during last half year was 7·1*d.* per train mile, of which 4·7*d.* represents the cost of production of the electric power, and 2·4*d.* the cost of utilising it on the locomotives. It is perhaps hardly a fair comparison to compare the cost of working such a line as the South London line with the cost of steam traction on other lines, inasmuch as steam could not possibly be used in the tunnels, only 10′ 6″ diameter, in which this line is constructed, but the comparison is not uninstructive. Take the Mersey Railway, where the gradients and nature of the traffic are similar. On the Mersey Railway the locomotives weigh about 70 tons, and the train, which is capable of carrying about 350 passengers, 150 tons. According to the published returns of the company the cost of locomotive power is 14*d.* per train mile, *i.e.* double the cost on the South London line, but for a train weighing between four and five times as much but capable of carrying only 3½ times the number of passengers; thus the cost of steam traction per ton mile of train is about half that per ton mile of train for electric traction. But it is not on the cost per ton mile that the success of a passenger line depends. The real basis of comparison is the cost per passenger mile, and here electric traction has great advantage over steam, as the dead weight of the electric motor is small compared with the dead weight of steam locomotives of the same power, and with electric motors the trains can be split up into smaller units at but slightly increased cost, so permitting a more frequent service. We cannot expect, therefore, that electric traction with our present knowledge will take the place of steam traction on our trunk lines; but it has its proper function in the working of the underground lines now projected for London, Paris, Berlin, and Brussels, and other large towns, and also I think on other urban lines, for example, on the Liverpool Overhead Railway, where trains of large carrying capacity are not required, but a frequent service is essential; and finally, also on those short lines, whether independent or branches of the great trunk lines where water power is available. When I undertook the construction of the Bessbrook line it was a condition that the cost of working should be less than the cost of working by steam, a condition which the first six months of working showed to be successfully fulfilled. When Messrs. Mather and Platt undertook the construction of the electric plant for the City and South London Railway, they guaranteed that the cost of traction for a service of 8247 miles per week as actually run should not exceed 6·3*d.* per train mile, exclusive of the drivers' wages. Their anticipations have been more than realised, the actual cost being 5·1*d.* per train mile only. There are, however, other projects both in America and on the continent for electric railways on which the special feature is to be an enormously high speed of travel, speeds of 150 and even 200 miles per hour being promised. With a steam locomotive, involving the reciprocating motion of the piston and connecting rod, such speeds are probably unattainable, but they may be realised in the purely rotary motion of an electric motor. But at such high speeds as these the power required to overcome the air resistance is of special consideration. Probably up to speeds of 750 miles per hour, or even to higher limits still, the ordinary law of air resistance holds good, as the rate of disturbance is still less than the velocity of waves in air, but above these limits we leave the regions of ordinary locomotion and enter rather into the field of projectiles. Assuming, however, that the ordinary laws of air resistance do hold good, I calculate that the power required to propel an ordinary train 200 feet long at 200 miles per hour against the

resistance of air alone, apart from the frictional resistances, would not be less than 1700 horse power. Though there is nothing to prevent the construction of electric locomotives capable of developing this or even greater power, the strength of the materials at present at command will set a limit to the speeds which may be obtained.

In order that the engineer may realise the imperfection of all his works, it is well for him to be constrained from time to time to contemplate the amount of energy involved in his final purpose compared with the energy of the coal with which he starts. I have endeavoured to put before you to-night the losses that occur and the reasons for them, in some steps of the complex machine which constitutes an electric railway, so in conclusion I will draw your attention to the ultimate efficiency of the machine, starting with the coal and ending with the passenger carried through space. The diagram on the wall, starting with the familiar 12,000,000 foot-pounds, the energy of a pound of coal, shows the loss in each step, supposing it made with the most economical appliances known to the engineer, first in the boiler, then in the steam engine, generator dynamo, conductors, locomotives, in the dead weight of the train, till finally we arrive at the energy expended on the passenger himself, which we find to be 133,000 foot-pounds, or but little more than 1 per cent. of the energy with which we started. It is true indeed that transportation is a more economical process than lighting with incandescent lamps, in which the final efficiency is about one-half per cent., but whether in lighting or in traction, when we consider that ninety-nine parts are now wasted for one part saved, we may realise that the future has greater possibilities than anything accomplished in the past.

HAIL STORMS.[1]

SOME recent thunder and hail storms were so violent that they call for more than a passing notice, not only on account of their severity, but also because they are well marked phenomena in our weather. The district in which they were most severe is that around Narrabri, and the weather map for the day indicated this district as one in which storms would probably manifest great intensity. The places from which the best accounts have reached me are Narrabri, Avondale, thirty miles due north of Narrabri, and Tulcumbah, fifty-seven miles south-east of Narrabri.

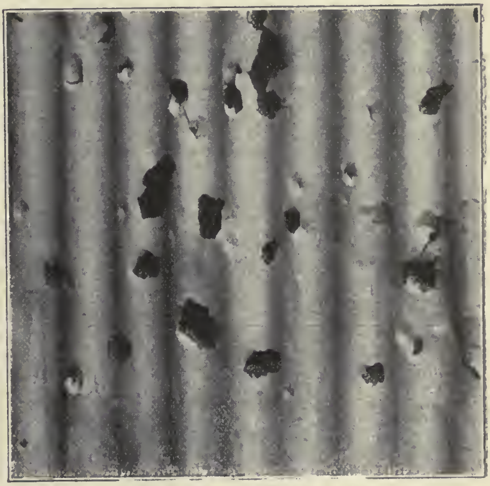
The Sydney weather chart at 9 a.m. on October 13, the day of these storms, shows us that there was but little difference in pressure all over Australia. To the west of the overland telegraph line it was slightly higher, over western New South Wales and Queensland lower, and higher again over the East Coast, in which the isobars clearly outline the area of relatively low pressure, and the kinks in them indicate disturbed conditions, local short-lived storms, and before the day was over the inference from the state of pressure was fully justified, for storms of extreme violence occurred over the area; storms which swept down great forest trees two and three feet in diameter. What this means in wind velocity I am unable to say, the trees are eucalypts, and therefore the wood is hard and very strong, but they were treated as if they were reeds, and their strength was as nothing compared with the force of the wind.

These storms are common enough, but owing to the sparse population they seldom pass over towns or dwellings. In this instance such has been the case, and in the future as population increases similar cases must increase in number, for the storms are abundant, indeed these storms form a well-marked feature of our summer weather. As a rule they are disconnected, and the most violent part of the wind covers but two hundred or three hundred yards wide, and travels along with great rapidity, leaving a narrow line of destruction in its wake.

On the day in question heavy storms were reported at Goodooga, Armidale, two hundred and forty miles south-east of Goodooga, and at Grafton one hundred miles north-east of Armidale. Storms which seem to have been quite disconnected, for the earliest time was at Grafton, and as a rule they come from the west; these are spoken of as severe storms, but were evidently not specially remarkable, nothing to compare with those in the Narrabri district to which I wish to direct your attention. Unfortunately, data for determining the rate of progress is not available, although that as to the intensity of the storms is abundant. I may mention that three days before these storms, that is on October 10, a similar storm passed over from Wilcannia to Sydney, a distance of four hundred and eighty miles, at the rate of fifty-five miles per hour; and I have before traced one over the same part of the colony, the rate being fifty-seven miles per hour, but we have not traced a sufficient number to determine an average rate.

As to the velocity of the wind along the line of damage in these storms, we have no actual anemometer results, so far we have not had one which passed over one of the anemometers, but judging from the damage done to large and solid trees, two and even three feet in diameter, it cannot I think be less than one hundred and forty or one hundred and fifty miles per hour.

We may now turn to the storms in the Narrabri district. The storm reached Narrabri at 6.15 p.m., and the postmaster reports that the storm which approached Narrabri from north-west was accompained by thunder and lightning, but no hail. The wind, however, seems to have been of hurricane violence, trees two feet in diameter were torn up by the roots, limbs twelve inches through were snapped off short, a brick factory completely ruined, roofs, sign-boards, and everything that the wind could move went flying; in the language of the local newspaper, "substantial brick buildings came tumbling in all directions, the air was full of iron tubs, galvanised iron, and tins of every description."



Photograph of iron perforated by hail.

In the district south of Narrabri the storm was even more severe. At Tulcumbah Station, fifty-seven miles south-east from Narrabri, at 8 p.m. on October 13, a violent thunder and hail storm broke over the homestead. It lasted half an hour, and Mr. A. D. Griffiths, my informant and manager of the station, says, "I measured some of the hailstones, six and a half inches in circumference; this was fifteen or twenty minutes after the storm, and I think I did not get the largest. Next morning I found that nineteen sheep had been killed by the hail, also birds, kangaroo-rats, and other animals were found lying dead in all directions. All the windows exposed to the storm were broken, and the galvanised iron roofing is dented from end to end, and many sheets cut through: in several cases the hailstones went through the iron; in one sheet I found thirty holes, and in another more than sixty. The bark of the trees in the storm track was all battered by the hail, and the fences and buildings bore traces of the impact of these great lumps of ice. The stones were generally triangular or conoidal in form, many having an uneven surface, which looked as if it had been formed from frozen drops of water collected into masses; others had an opaque snow-like centre, perhaps the majority were like this, the remainder being like clear ice. It was only the larger stones that were irregular as described, the smaller ones were generally rounded."

At Avondale, thirty miles north of Narrabri, my informant,

[1] Read by H. C. Russell, F.R.S. before the Royal Society of N.S. Wales, November 2, 1892.

Mr. S. J. Dickson, says, "From the 9th to the 13th of October, he weather was unusually oppressive with threatening storms, and on the evening of the 13th a heavy storm was seen to be working up from the west accompanied by incessant lightning of every description, and about 8 p.m. it broke over the homestead in all its fury, the wind was from south-west and of terrific force, and the rain and hail were very severe. The hailstones were as large as hen-eggs, and in some of the paddocks, one particularly, it pounded the herbage completely out, so that not a vestige of it was left, although before the storm came on it was from six to twelve inches high, and in other places strong variegated thistles three to four feet high were beaten down. Trees some two feet thick, that the wind could not tear up by the roots, were snapped off short as if made of matchwood. In the storm the hail killed birds innumerable, and even domestic fowls roosting on the trees were killed by it, and after the storm a large snake was found cut into two pieces by the hail, so at least it appeared. On the open plain the hail laid four to six inches deep, and the whole country looked as if a heavy snowstorm had passed over it. Trees in the track of the hail were completely denuded of leaves, and the bark knocked off tree trunks and limbs. The storm wind carried away outstations, unroofed the hayshed, damaged the woolshed, and carried away two sides of the house-verandah, and the sheets of iron from it were found nearly half a mile (30 chains) away to the north-east, round wall plates in the hayshed six to eight inches thick were broken to pieces, and the iron roofing on all the buildings was battered by the hail as if some one had pounded it with a hammer all over. The storm track was only a mile to a mile and a half wide, at least the hail part. Between 7 and 8 p.m., as the storm came up, there seemed to be a white bow in the sky, like a white rainbow stretching from north to south. I have seen heavy storms before, but I never wish to see another like this. The shearers were completely terrified, and all say that they have never experienced a storm like it, in fact, it beggars description and can hardly be realised. It was an experience that we shall remember as long as we live."

North of Narrabri, and especially between Narrabri and Avondale, the storms were very severe. Midway between these places and at Terry-hi-hi and Berrigal Creek the wind worked great destruction in the forest. How violent it was may be gathered from the fact that great trees twelve feet in circumference at three feet from the ground, were snapped off short ten feet above the ground, or entirely stripped of their limbs.

SCIENTIFIC SERIAL.

American Meteorological Journal, March.—Exploration of the free air, by Prof. M. W. Harrington. The author considers that the conclusions to be drawn from weather maps are nearly exhausted, and that the reason of the imperfection of meteorology is the want of knowledge of what is going on in the free air. Mountain observations give most important results, but they are still surface observations. We know what goes on at the base of a cyclone, but not what occurs at the top. Theories are deduced from cloud observations, but we lack actual knowledge of what is going on above, and the only means available at present is systematic balloon observations. Prof. Harrington thinks that such observations should be provided for by funds from private sources.—The general winds of the Atlantic Ocean, by Prof. W. M. Davis. The basis of this discussion is the "Sailing Directory of the Atlantic Ocean," published by the Deutsche Seewarte, and especially two generalised wind charts contained in the atlas accompanying that work. The author classifies the winds as planetary (due to the earth's rotation and the influence of the sun), terrestrial (the annual migration of the wind belts north and south, and the seasonal variations of velocity and direction), including the interruptions of continents and mountain ranges.—The colours of cloudy condensation, by Prof. C. Barus. The author considers the problems connected with the condensation of water from moist air, and reviews the labours of Mr. Aitken and Mr. Bidwell with reference to the particles of an opaque steam-jet. He also gives a minute description of the apparatus employed in his own investigations.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, March 24.—Prof. A. W. Rücker, F.R.S., President, in the chair.—Several excellent photographs of flying bullets and of the air waves produced by vibrating hammers, were exhibited, the originals of which had been taken by Prof. Mach.—A paper on the differential equation of electric flow was read by Mr. T. H. Blakesley. The object of the paper is to show that the ordinary mathematical expressions for electric flow fail to explain all known facts, and to point out that in order to interpret these facts certain properties of matter not usually recognised must be admitted. The subject is treated both algebraically and geometrically, in the latter case the magnitudes being represented by the projections of the sides of a triangle revolving in its own plane on a fixed line in that plane. Taking the ordinary differential equation for a simple circuit having resistance and self-induction, viz., $V - L\frac{dC}{dt} = RC$, it is shown that this takes no account of any energy except that spent in heating the conductor, and that where radiation into space is concerned, it is necessary to introduce another term λC, where λ is a quantity of the nature of resistance. It is further pointed out that if work be done outside the circuit, the line which geometrically represents the induced E.M.F. cannot be perpendicular to that indicating the current and "effective" E.M.F., the latter term being defined to mean the value of the quantity which is numerically equal to the product of the current into the resistance. A magnetic phase-lag must therefore exist. The author also shows that a magnetic field induced in phase with the magnetic induction would not result in a loss of energy, and no hysteresis could exist. Under the same circumstances there could be no radiation of energy from an alternating magnet. A Leyden jar discharging through a circuit having self-induction is next considered. Taking the ordinary premises, it is shown that no provision is there made for energy radiated into space, and that magnetic lag is necessary for the existence of such phenomena. The differential equations for the variables in condenser discharges according to ordinary assumptions are shown to be of the same form, and the variables can be represented by the projection of the sides of a triangle which is simultaneously undergoing uniform rotation and linear logarithmic shrinking. The rate of shrinking is the same as that of the radius vector of an equiangular spiral of characteristic angle β, where $\cos\beta = \sqrt{\frac{K}{L}} \cdot \frac{R}{2}$; K, L, and R representing capacity, self-induction, and resistance respectively. The equations and their consequences are considered at some length, and several important properties brought out. To allow for radiated energy, R must be virtually increased from R to $R+\lambda$, and the total energy is divided between the circuit and the field in the ratio of R to λ. If, therefore, the circumstances be such that λ is large compared with R, say by having high frequency, the heating of the circuit may only be a small part of the total energy. In this direction the author thinks the true explanation of some of Tesla's experiments is to be found, the energy being expended chiefly in radiation and not in current through the experimenter's body. Prof. Perry thought the C^2R term would not represent the heating of the wire when the oscillations were rapid, owing to the distribution of current not being uniform over the section of the conductor. Maxwell had shown that certain throttling terms had to be considered. In condenser discharges the complete equation would have many terms. Prof. O. J. Lodge said the best definition of R in such case. was that derived from Joule's law rather than that of Ohms Frequency was very important in the radiation of energy, but even at ordinary frequencies of alternators some energy was radiated. Referring to Tesla's experiments, he said the reason why no serious consequences followed, was that there was not much energy behind them. High frequency might be instrumental in preventing injury, but this he thought remained to be proved. Dr. Sumpner pointed out that losses other than C^2R (R being the ordinary resistance of the conductor) had to be taken into account. In some cases, such as transformers on open circuit, the effective resistance might be 1000 times that of the coil. To discuss completely the problem taken up by Mr. Blakesley, it would be necessary to take account of non-uniform distribution of current, both across and along the conductor, as well as the character of the magnetic and electric fields surrounding the circuit. Mr. Swinburne thought there was a tendency to over-estimate the rate of high-frequency currents, for unless the coils of transformers were assumed geometrically coincident, calculations were difficult. Errors of hundreds per cent. were quite possible. In Tesla's experiments no great power was involved, for the transformer could not give out any large power. Mr. Blakesley, in reply, said the

term R was such that C^2R represented the whole waste loss in the conductor, whilst λ included everything wasted outside the conductor.—A paper on the viscosity of liquids, by Prof. J. Perry, F.R.S., assisted by J. Graham and C. W. Heath, was read by Prof. Perry. The viscosity was tested by suspending a hollow cylinder within an annular trough containing the liquid, and measuring the torque exerted on the cylinder when the trough rotated at various speeds about its axis. In the paper the equation of motion under the conditions of the experiment is discussed, the error introduced by assuming that the liquid moves in plane layers being shown to be about 0·5 per cent. By measuring the viscous torques exerted with different depths of liquid in the trough, the correction for the edge of the suspended cylinder was found to be 0·8 c.m. On plotting the results obtained with sperm oil at different temperatures and constant speed, a discontinuity was noticed about 40°. For a speed of nine revolutions a minute the viscosity (μ) could be very approximately calculated from the formula $\mu = 2{\cdot}06 (\theta - 4{\cdot}2)^{-{\cdot}656}$ below 40° C. and $\mu = 21{\cdot}67 (\theta - 4{\cdot}2)^{-1{\cdot}349}$ above 40° C., θ being the temperature. Experiments on the change of density of sperm oil with temperature, made by Mr. J. B. Knight, indicated a minimum density about 40°. Subsequent experiments with other samples had not confirmed these observations. The paper contains several tables of the results obtained in various experiments. Those performed at constant temperatures show that for slow speeds the torque is strictly proportional to speed, but afterwards increases more rapidly, probably owing to the critical speed having been exceeded. After concluding the paper Prof. Perry read a letter he had received from Prof. Osborne Reynolds on the subject, who doubted whether the true critical velocities had been reached in the experiments. In the particular arrangement employed, he would expect no critical velocity in the outer ring of liquid, whilst in the inner ring the motion would be unstable from the first. Mr. Rogers pointed out that experiments which corroborated those of Prof. Perry had been made by M. Couette and published in *Ann. de Chim. et de Phys.* [6] xxi.

Geological Society, March 22.—W. H. Hudleston, F.R.S., President, in the chair.—The following communications were read:—On the jaw of a new carnivorous dinosaur from the Oxford clay of Peterborough, by R. Lydekker. The author describes a fragment of the left side of a lower jaw of a carnivorous dinosaur from the Oxford clay of Peterborough, indicating a new genus and species, which he names *Sarcolestes Leedsi*. Some remarks were made on this paper by the President and Prof. Seeley.—On a mammalian incisor from the Wealden of Hastings, by R. Lydekker. In this paper a small rodent-like tooth from the Wealden of Hastings, belonging to Sir John Evans, K.C.B., is described. It is probably the front tooth of one of the mammalian genera found in the Purbeck Beds, as may be gathered from American specimens. The reading of this paper was followed by a discussion, in which the President, Sir John Evans, Mr. C. Dawson, Mr. Oldfield Thomas, Dr. Forsyth-Major, Dr. H. Woodward, and the author took part.—On an intrusion of Muscovite-biotite-gneiss in the south-eastern Highlands, and its accompanying thermo-metamorphism, by George Barrow, of the Geological Survey. (Communicated by permission of the Director-General of the Geological Survey.) The area to which this paper refers lies in the north-eastern part of Forfarshire, and is drained by the two Esks. The author first describes the distribution, mode of occurrence, and petrological characters of the intrusive masses. In the north-western portion of the area the intrusive rock is always a gneiss, and occurs in thin tongues which permeate the surrounding rocks. Towards the south-east these tongues amalgamate and form large masses, in which the foliation is less marked. Moreover, in this direction the large masses are often fringed with pegmatite, especially on their southern and eastern edges. Where the rock is a gneiss, it is composed of oligoclase, muscovite, biotite, and quartz, but contains no microcline. As the gneissose character becomes less marked, the oligoclase diminishes in amount, and microcline begins to appear, especially towards the margins of the masses. In the most south-easterly of these microcline is greatly in excess of oligoclase. The differences in structure and composition of these masses are believed by the author to be due to the straining off of the crystals of earlier consolidation during intrusion under great pressure. The still liquid potash-bearing portion of the magma was squeezed out and forced into every plane of weakness in the surrounding rocks; and that portion of it which contained the highest percentage of potash finally consolidated as pegmatite. Special attention is directed to the distribution of pegmatite. This rock is widely distributed in the Southern Highlands, and cuts across every known system of folding. It is consequently newer than any member of the metamorphic series. The surrounding metamorphic schists are next dealt with. These are remarkable for their highly crystalline condition, and also on account of the presence of many minerals known to occur in regions where thermo-metamorphism has taken place. The characters of the more important minerals are described in detail. The rocks of the metamphoric area become less and less crystalline as they are followed towards the Highland border. Three zones, characterised respectively by the minerals sillimanite, cyanite, and staurolite, have been roughly mapped. The more important rocks found in these zones are described in detail, and evidence is given to show that the boundaries between the zones do not in all cases coincide with the strike of the rocks. Thus, a thin bed of quartzite, which retains its character in consequence of the simplicity of its chemical composition, may be followed through all the zones; whereas the bed adjacent to it is in the outer zone a staurolite-schist, in the intermediate zone a cyanite-gneiss, and near the contact with the igneous rock a coarse sillimanite-gneiss. Evidence is given to show that the original rocks formed a sedimentary series. The phenomena are compared with those of other areas where thermo-metamorphism has taken place; and the conclusion is reached that the differences are of *degree* rather than of *kind*. The special features of the area in question are attributed to the depth at which the change was produced. The paper is illustrated by a map of the district and a table of original analyses. This paper gave rise to a discussion, in which the president, Prof. Judd, Mr. Rutley, General McMahon, Dr. Hicks, Mr. Marr, Dr. Du Riche Preller, Mr. Teall, and the author took part.

Zoological Society, March 28.—Sir W. H. Flower, K.C.B., LL.D., F.R.S., President, in the chair.—A report was read, drawn up by Mr. A. Thomson, the Society's head-keeper, on the insects bred in the insect-house during the past season.—A communication was read from Mr. Herbert Druce, giving an account of some new species of Lepidoptera Heterocera, chiefly from Central and South America.—Mr. F. E. Beddard, F.R.S., read a paper on the brain of the African elephant. The author gave reasons for disagreeing with some of the conclusions of Dr. Krueg, but confirmed otheıs. The outline is more like that of the carnivorous than the ungulate brain, but the principal furrows appear to be arranged on a plan characteristic of the elephantidæ.—Mr. W. T. Blanford showed that the various names hitherto employed in systematic works for the bird called by Jerdon the Himalayan cuckoo (*Cuculus himalayanus*, *C. striatus*, and *C. intermedius*) belonged to other species. He also gave reasons for not adopting S. Müller's *C. canoroides*, and accepted the term *C. saturatus*, Hodgson, as the correct scientific name.—A communication was read from Mr. F. M. Woodward, entitled "Further observations on the genitalia of British earthworms." This paper chiefly dealt with supplementary gonads which were found to be much more common than had been supposed; in one specimen an hermaphrodite gland was discovered in addition to testes and ovaries.

Entomological Society, March 29.—Henry John Elwes, President, in the chair.—Mr. G. C. Champion exhibited a living specimen of a luminous species of *Pyrophorus*, which had been found in an orchid house in Dorking. It was supposed to have emerged from the roots of a species of *Cattleya* from Colombia.—Mr. A. H. Jones exhibited living full-grown larvæ of *Charaxes jasius*, found by Mr. Frederic Raine, at Hyères, feeding on *Arbutus unedo*.—Surgeon-Captain Manders exhibited a series of *Lycæna theophrastus* from Rawal Pindi, showing climatal variations, the rainy-season form being of darker coloration, and larger than that occurring in the dry season. The ground colour of the former on the under surface was markedly white with deep black striæ; in the latter form the ground colour was distinctly reddish, and the marking reduced to reddish lines. He said that the latter form had been described as *L. alteratus*.—Mr. S. G. C. Russell exhibited a beautiful variety of *Argynnis selene*, taken near Fleet, Hants; two varieties of *A. selene* from Abbot's Wood, Sussex; typical specimens of *A. selene* and *A. euphrosyne* for comparison; and

a remarkable variety of *Pieris napi* from Woking.—Mr. C. J. Gahan exhibited a microscopic preparation of the antenna of the larva of a beetle (*Pterostichus*), for the purpose of demonstrating the sensory nature of the so-called "appendix" of the antenna. Since he wrote a note describing this structure, a short time ago, he found that Prof. Beauregard had already suggested its sensory character, and was inclined to believe that it was an auditory organ.—Mr. H. Goss exhibited a specimen of *Trogus lapidator*, Grav., believed to have been bred from a larva of *Papilio machaon*, taken in Norfolk by Major-General Carden. Mr. Goss stated that he sent the specimen to the Rev. T. A. Marshall, who said it was a well-known parasite of *P. machaon* on the Continent, but not proved to exist in the United Kingdom.—Mr. F. Merrifield said he knew this parasite, and had bred several specimens of it from pupæ of *P. machaon* received from Spain.—Colonel Swinhoe read a paper, entitled "The Lepidoptera of the Khasia Hills. Part I." A long and interesting discussion ensued, in which Mr. Elwes, Mr. Hampson, Colonel Swinhoe and others took part.—Mr. W. Bartlett-Calvert communicated a paper entitled "New Chilian Lepidoptera."—Mr. J. W. Shipp communicated a paper entitled "On a New Species of the Genus *Phalacrognathus*."

Paris.

Academy of Sciences, April 4.—M. Lœwy in the chair.—On the construction of the chart of the heavens; numerical application of the method of attaching neighbouring negatives, by M. Maurice Lœwy.—Remarks on M. Joubin's note relating to the measurement of large differences of phase in white light, by M. A. Cornu.—On the approximate representation of experimental functions between given limits, by M. Vallier.—On the benzeneazocyanacetic ethers and their analogues, by MM. A. Haller and E. Brancovici.—Measurement of the parallel of 47° 30′ in Russia, by M. Venukoff. The parallel was measured from the meridian of Kichinev, near the Roumanian frontier, to that of Astrakhan, on the Lower Volga, the difference of longitude being 19° 11′ 55″·11. The measurements gave 1,446,462 m. for the length of the arc, or 75,336 m. per degree of longitude. But this mean value is not everywhere attained. Between Rostov-on-the-Don and Sarepta the geodetic arc exceeds the astronomical one by 15″·26, whilst between Sarepta and Astrakhan the astronomical arc is the larger by 9″·82. This deviation shows a remarkable agreement with that obtained in the measurement of the 52nd parallel and indicates that the plains of Eastern Russia are formed according to the same geometrical law over a vast area. A comparison of the results for the two arcs, with reference to the length of the meridian measured from the North Cape to Dorpat and the Lower Danube, indicates a polar depression of 1 in 299·65, which agrees closely with that found by Bessel for Germany in 1841 (1 in 299·26), but differs from that of Clarke (1 in 293·46).—Condensation experiments of the acetylcyanacetic acids with the phenols, by M. A. Held.—Synthesis of erythrite, by M. G. Griner.—Action of temperature upon the rotatory power of liquids, by M. A. Aignan. Reasoning from the fact that the oxide of isobutylamyl presents a rotatory power which changes its sign at −30°, M. Colson has concluded that "chemical constitution does not appear to be the preponderating factor in the value or the sign of the rotatory power." But the fact referred to can be explained as the effect of the mixture of a negative and a positive rotating substance respectively. A mixture of essence of terebenthine (left-handed) and camphor (right-handed) was dissolved in benzene, and observed through the 20 cm. tube of the polarimeter in different kinds of light. This mixture changed from negative to positive at a temperature between 61° and 73° C. for red light, between 13° and 33° C. for yellow light, and was positive for all the temperatures for green light, the angle of rotation being 2° 24′ at 13°, and 6° 43′ at 90° C. To explain M. Colson's observation, it is not even necessary to assume that the oxide contains two substances of rotatory powers of different signs. It suffices to admit, as has been done in the case of solutions of tartaric acid, that the molecules of isobutylamyl are susceptible of polymerisation in the liquid state, so that the sign of the rotatory power characterising the molecule of the substance is that observed at the higher temperatures.—Neolithic village of the Roche-au-Diable, near Tesnières, canton of Lorez-le-Bocage (Seine-et-Marne), by M. Armand Viré. In the course of excavations in the valley of Lunain a village was discovered of a type not met with up to now. It consists of a series of ground-works of square huts touching each other, and arranged in a line nearly east and west, forming a very regular street. At the end was a sort of square enclosure of stone, measuring about 2·5 by 3 m., with a door towards the south. Inside it presented a circular cavity, 30 cm. in diameter and 20 cm. deep, which still appeared to contain ashes, and whose clay walls were baked to a depth of about 4 cm. Similar hearths have been found among the Kabyles of Algiers. Near this structure was another, of circular form, built of rough blocks of limestone and sandstone, with a triangular door built of two enormous blocks of sandstone, joining at the top, and leaving a space of 50 cm. at the bottom. This hut also showed traces of cooking operations. A little further on came a series of seven similar huts, followed by two larger ones without hearths, and finally two more like the first. The total length of the village was 114 m. All the masonry consisted of blocks of limestone or sandstone, cemented with clay. A large number of stone and flint implements was found, including half a dozen sandstone hatchets, polished or prepared for polishing. The village is, curiously enough, situated at the very bottom of the valley.

BOOKS AND PAMPHLETS RECEIVED.

Books.—Exercises in Euclid: W. Weeks (Macmillan).—Electrical Tables and Memoranda: S. P. Thompson and E. Thomas (Spon).—Popular Lectures on Scientific Subjects: H. von Helmholtz, 2 vols. new edition, translated by E. Atkinson (Longmans).—Aids to Biology: J. W. Williams (Baillière).—Statics and Dynamics: E. Geldard (Longmans).—Map of River Basins: C. E. De Rance (Manchester, J. E. Cornish).—Telephone Lines and their Properties: W. J. Hopkins (Longmans)—The Birds of Derbyshire: F. B. Whitlock (Bemrose).—Theory of Functions of a Complex Variable: Dr. A. R. Forsyth (Cambridge University Press).—Theory of Structures and Strength of Materials: H. T. Bovey (K. Paul).—Die Thermodynamik in der Chemie: J. J. Van Laar (Leipzig, Engelmann).—Polarisation Rotatoire: G. Foussereau (Paris, G. Carré).—Traité Pratique d'Analyse Chimique et de Recherches Toxicologiques: G. Guérin (Paris, G. Carré).—Forest Tithes, &c.: A Son of the Marshes (Smith, Elder).—Technology for Schools: J. Hassell (Blackie).—A Practical Treatise on Bridge Construction, 2 vols.: T. C. Fidler (Griffin).—The Steam-Engine, 2 vols: D. K. Clark (Blackie).

Pamphlets.—Sulla Distribuzione del Potenziale Nell'Aria Rarefatta percorsa dalla Corrente Elettrica: Prof. A. Righi (Bologna).—The Fundamental Theorems of Analysis Generalised for Space: Prof. A. Macfarlane (Boston).—The Imaginary of Algebra: Prof. A. Macfarlane (Salem).—Australian Museum, Sydney; Catalogue of Australian Mammals, &c. (Sydney).—Catalogue of the Michigan Mining School, Houghton, Michigan, 1891-92 (Houghton).

CONTENTS.

THURSDAY, APRIL 20, 1893.

THE NEW UNIVERSITY FOR LONDON.

THE long procession of witnesses which for months past has been defiling before the "Gresham University Commission" has at length come to an end. The Commissioners are now, we suppose, engaged in constructing a scheme for the constitution of the University. Their manner of performing the first portion of their task has been open to criticism. More may be heard hereafter of the extraordinary refusal to furnish the witnesses with copies of their own evidence, and of the still more remarkable fact that, though the majority were denied copies of what they themselves had said, exceptions were made in the case of certain favoured persons who were allowed to see and to contradict the evidence of others.

While the Commission has been sitting several schemes for the constitution of the new University have been proposed. In spite of certain important differences there is one most important point on which they are generally in accord. It is not too much to say that—with no more exceptions than are necessary to prove the rule—every one interested in the future development of the higher education in London agrees that there should be but one university in the metropolis, and that it should not (as was proposed in the discredited Gresham scheme) be a loose federation of competing colleges. It cannot be too strongly urged that the object of a university is the promotion and the diffusion of learning, not the aggrandisement of educational institutions. Every student in London who can pass the prescribed examinations can at present obtain a degree. No change in existing arrangements need be made unless it can be shown by some other method students could be attracted in greater numbers, or could be turned out at the end of their university careers with a greater mastery of the branches of knowledge which they have studied. These ends will not be attained by giving to the existing colleges the right to agree among themselves as to the conditions on which degrees are to be bestowed, and leaving the existing university as a rival whom they will immediately be tempted to undersell. If public money were bestowed on such a university it would merely be scrambled for by the constituent colleges, and would be spent in a rivalry in which the minimum advantage to learning would be produced by the maximum waste of funds.

If London is to have a University worthy of the name, if Parliament, the City Companies, and the London County Council are to provide it with the means absolutely necessary for its proper equipment, the University must be endowed with powers which will enable it to fashion the Colleges to meet the needs of London. It must be freed from, not fettered and hampered by, the necessity of maintaining in precisely their present form arrangements which are themselves in large measure the result of the religious animosities of fifty years ago.

But while this fundamental fact must in every way be insisted on, it would, of course, be absurd to attempt to compel the governing bodies of existing institutions to surrender all their rights off hand, or to treat as hostile men who have been doing their best for the public good amid great difficulties and with too little public sympathy. We cannot, therefore, but hope that the Commission may recommend, and the Colleges accept, some such plan as that recently proposed by the Professorial Association.

In this scheme a praiseworthy attempt has been made to combine a rigid insistance on the conditions necessary for the future success of the University, with a due regard for the susceptibilities of the Colleges out of which it will in part be constituted. It is proposed that the Governing Body shall consist of the Chancellor and the Vice-Chancellor, and twenty-five Professors (each of whom shall be elected annually by the Professors of a definite group of cognate subjects), together with fourteen members nominated by the Crown, four members nominated by its Corporation and the London County Council, three representatives of Convocation, and four members, not being teachers in the University, nominated by the Governing Body itself.

The last provision would enable the Court—as the Governing Body is called—to give temporary or permanent representation to public or semi-public bodies which it might be desirable to attach to the University. It is also proposed that the arrangements between the University and the existing colleges shall be negociated by a Statutory Commission with very wide powers, subject always to the condition that every Professor of the University, wherever he may teach, shall be appointed and paid by the University. To this Commission is entrusted the task of selecting in the first instance the fourteen members of the Court, whose successors will be nominated by the Crown. The choice is to be made "from among the existing members of the Senate of the University of London, and from members of the governing bodies of those colleges which may be incorporated, in such proportion as may seem advisable to the Commission, having regard to the importance of the vested interests involved, and to the magnitude of the educational resources which may be placed by each at the disposal of the new University. These initial appointments are to last for ten years, and at the end of ten years, or in the event of vacancy through death or resignation, the appointments are to be made by the Crown." Subject to the general control of the Court the Professors of the University are to have charge of all purely educational matters.

The colleges named as those which it is desirable to bring into connection with the University are (in alphabetical order) Bedford College, the Central Institution of the City and Guilds Institute, Gresham College, King's College, the Medical Schools, the Royal College of Science, and University College, while there are other institutions, especially those giving instruction in Fine Arts and in Law, with which it may be possible for the University to establish relations. It is also proposed that the University should have the power to appoint or to recognise teachers giving instruction of a more or less academic character at institutions or colleges, the objects

or the standing of which render complete incorporation with the University undesirable, and to institute "University Extension" lectures, always, however, subject to the condition that the teaching functions of the University are to be confined to the metropolitan area. The examinations of the existing University of London would of course be carried on, so that in this part of its work the University would maintain its connection with all parts of the kingdom, and indeed of the empire.

In all these points the suggestions of the Association appear to us to be eminently practical. It is hopeless to expect a solution of the problem to which every one will agree. The first desideratum is to secure the establishment of a new non-federal teaching University, and then to give a statutory commission the power to make bargains with the existing colleges, which must either assent to reasonable terms or be left outside the University altogether. If any Governing Body consents to a close incorporation with the University it will secure representation on the Court both from among its lay members and its Professors. When the University is fairly started the Crown will select persons who are or are not connected with the Colleges as may seem desirable. The Medical Schools will be free to make terms with the Statutory Commission or to remain independent as they please. Of course the Commission ought to be as strong as possible, and much will depend on it, but with the suggested constitution it would be impossible to make the University a federation. It would be independent of and superior to the Colleges. It would be powerful and important enough to bulk large even in London, and to attract help both from the State and the Municipality.

COMPARATIVE GEOLOGY.

Text Book of Comparative Geology. By E. Kayser, Ph.D., Professor of Geology in the University of Marburg. Translated and edited by Philip Lake, M.A., F.G.S., late Harkness Scholar in the University of Cambridge. With 596 Illustrations (73 plates and 70 figures in the text). (London: Swan Sonnenschein. New York: Macmillan and Co., 1893.)

AMONG works dealing with stratigraphical or historical geology, Dr. E. Kayser's "Lehrbuch der geologischen Formationskunde" holds a deservedly high place. The account given in this work of the several geological systems, as displayed in Germany, is very full and complete; and the comparisons of the German strata with their equivalents in other parts of Europe are for the most part judicious and accurate. A very striking and admirable feature of the book is its wealth of illustration; carefully selected specimens of the characteristic fossils of the several formations, are figured in such a way as to be clearly recognisable, and there is probably no text-book of the kind in which the number of forms thus represented is anything like so great.

We cannot but think that Mr. Lake has rendered a great service to geological students in this country by translating Dr. Kayser's admirable text-book; and for the general manner in which he has performed his task we have nothing but praise. When a detailed examination of the book is made, however, it is impossible not to be struck with a certain inequality of treatment on the part of the editor: and as we sincerely hope this excellent book may reach a second edition, it may be well to call attention to points in which it is certainly susceptible of improvement.

There are two ways in which a teacher of geology in any particular country may advantageously introduce his students to the comparative study of the several formations. He may, in the first instance, describe the formation as displayed in an area where his students can make direct acquaintance with it, and then proceed to point out the resemblances and differences presented by the various foreign equivalents of the formation; and there is certainly much to be said in favour of thus making geology "begin at home." But, inasmuch as the several systems of strata are very unequally developed in different areas, there is often a very obvious advantage in following a different plan. If the district in which the most perfect exhibition of a system of strata can be studied be selected as the *type*, and all other areas be directly compared with this typical representation of the system, it is evident that a more satisfactory account of a formation can thus be given in a limited space than is possible by the other method.

Now as regards the Palæozoic formations, we think that Mr. Lake has been very happy in the methods he has adopted. In the case of the Cambrian, Ordovician, Silurian, and Carboniferous systems, he has commenced with an account of their development in the British Islands. The Devonian and Permian are, however, differently dealt with, the type of the first being sought in the Eifel and of the second in Central Germany. Nothing could be better for the purpose aimed at than this blending of the two different methods of treatment to which we have referred.

In his preface the author acknowledges the assistance received from Mr. Marr and Prof. Lebour in preparing the account of the Palæozoic rocks; and every one must be satisfied with the general accuracy and fulness of treatment of the British strata and their equivalents, so far as the great Palæozoic systems are concerned.

The most serious criticism which we have to offer with respect to this earlier portion of the work is as regards the limits adopted for the Cambrian. Mr. Lake divides this system into three portions, characterised by the *Olenellus*, the *Paradoxides*, and the *Olenus* fauna respectively; he nevertheless takes away from the Cambrian the Tremadoc beds, in which *Olenus* is so abundant, and makes them the base of the Ordovician. We think that, in a work intended for English students, it would have been better to have followed the practice which has hitherto prevailed in this country, and to have included the Tremadoc in the Cambrian, giving a reference to Dr. Kayser's views in a footnote.

We also find in the preface an admission that "additions are most numerous in the first half of the work, while in the latter half the greatness of the subject and the limits of space have made themselves more severely felt." In the account of the Jurassic and Cretaceous strata there are not a few important facts with respect to the British representatives of those systems that are altogether omitted; while there is, we think, a dispropor-

tionate amount of space given to some foreign equivalents. It is when we come to the Tertiary strata, however, that we are most painfully impressed by the inadequacy of the treatment of some very essential matters. The British Eocenes have about half a page devoted to them; there is no mention of the Hampshire Basin as distinct from that of London; and the table of strata given is neither that of one basin nor the other, but an awkward combination of beds from both. The English Oligocene is dismissed in about a dozen lines, and no mention is made of the rich and varied marine fauna of the New Forest. About the same amount of space is devoted to the Pliocene of East Anglia (that of the South Downs and Cornwall not being even mentioned), while the highly-developed Pliocene of Belgium has assigned to it only a single line.

We make these remarks, not with any desire to find fault, but in order to call the author's attention to the fact that, in its present state, the work would be almost useless to an English student, unless he used it in conjunction with another geological text-book, in which the British formations had received more adequate treatment. If the more vigorous editing, which has made the first part of this book so excellent, were applied to the latter half of the volume, we should then have an almost perfect work, and one which would find a place in every scientific library.

With all its faults, however, we have a text-book of stratigraphical geology which is superior to all its predecessors in respect to its illustrations, and its thoroughness. The copious index is of the greatest value, though the work would be improved by some additions to the references and the substitution in all cases of citations of original memoirs in the place of works giving information at second hand.

The plan of treatment of the several geological systems is excellent. The historical account of the establishment of the particular division and grouping of the strata is followed by sketches of the development of the system in the chief European areas, concluding in certain cases with shorter notices of some of the extra-European equivalents. This account of the stratigraphy of the system is followed by an admirable sketch of its palæontology.

There are two portions of the book which, to make the work suitable as a manual for English students, require to be greatly modified, if not altogether rewritten. These are the chapters relating to the Archæan and the "Diluvium" respectively. We can readily understand that the editor would shrink from so drastic a remedy as we suggest, and yet the views expressed in the book before us, upon the oldest and youngest of the formations respectively, are so entirely at variance with those which the beginner is likely to hear from any recognised teacher of geology in this country, that it is scarcely fair to students to allow them to stand in their present form. In the same way the uncompromising statements concerning the difference between the eruptive rocks associated with the tertiary and those of older geological epochs require serious qualification. If the editor felt that he could not, in fairness to the original author, make the necessary omissions or alterations in the text, he might have appended notes in which the attention of the student is called to statements that are at variance with the instruction he would ordinarily receive in this country.

Although we have felt it to be our duty to call attention to certain imperfections and blemishes in this book, we must repeat our verdict concerning its general excellence, and the hope that an opportunity will soon be afforded to its editor of preparing a second edition, in which these imperfections and blemishes may be removed.

THE BALTIC SHIP-CANAL.

Der Nord-Ostsee-Kanal. Von C. Beseke. (Kiel and Leipsic: Lipsius and Tischer, 1893.)

FOREMOST among the engineering works of the latter part of the nineteenth century must assuredly be placed the magnificent maritime canals, which afford such conspicuous evidence of industrial skill and enterprise; and of these great works few will yield in point of size and importance to the new sea-way between the North Sea and the Baltic, the history and progress of which is so ably described by Herr Beseke in the present volume.

The idea of such a canal has been under consideration for five centuries, and one of the most interesting chapters in the book is that which enumerates no less than sixteen schemes which have from time to time been propounded for the accomplishment of this difficult problem. These different projects are rendered all the more intelligible by means of a sketch-map, indicating the various lines proposed, the majority of which, having their origin in the estuary of the Elbe, passed transversely across the Schleswig-Holstein peninsula to points in the vicinity of Kiel or Lübeck.

The inception of the present undertaking dates from October 19, 1883, when the Chancellor of State was directed by Imperial rescript to report upon the execution of a canal from Kiel to the mouth of the Elbe. The plans, prepared in conformity with this decree, were adopted, with trifling modifications, on March 16, 1886, the execution of the works being entrusted to a State Commission in July of the same year, and the first stone was laid by the Emperor William I. with an imposing ceremony on June 3, 1887.

The total length of the projected canal is about 61 English miles, the width at the water-line is 197 feet, and at the bottom, at the toe of the slopes, 72 feet; the total depth is nearly 28 feet. It is shown by means of a diagram that not only will two of the largest Baltic merchant vessels pass one another without difficulty, but also that there is room for a vessel of this type to give way to one of the finest ironclads of the German navy, such as the *König Wilhelm*, with a displacement of 9757 tons. Special passing stations have, however, also been arranged at intervals, similar to those on the Suez Canal.

The cost of the works was originally estimated at £7,800,000, which provides for 77,400,000 cubic metres of excavation, and all requisite contractors' plant and materials, entrance locks, bridges, and harbour works, as also for the forts needed to protect the western approach to the canal.

A most curious chapter is that which deals with the provision made for the conduct of the enterprise, and for the housing and accommodation of the large staff of workpeople engaged therein. The sub-contractors for

the various sections into which the works were divided—15 in number—had, under conditions carefully specified, to construct barracks for the staff of workers. The canteen arrangements were all carefully thought out, and the prices of food were regulated by fixed tariffs. The sizes of dormitories were prescribed; hospitals and laundries have to be provided, and all the sanitary arrangements appear to be most complete.

It was a condition of their engagement that the work-people should be at least seventeen years of age, no Socialists or Anarchists might be employed, and all drunken and dissolute persons were liable to instant dismissal. Some of the regulations appear slightly autocratic, but doubtless with a population of from 6000 to 8000 persons brought together from all parts of Germany, such as was to be found on certain of the sections, it was necessary to insist upon a very severe discipline. We are assured by the author that hitherto these rules have worked satisfactorily. A detailed account is given of the four bridges required for the railway crossings, also of the numerous ferries and of the massive constructions needed to form the entrance-locks of the canal at either end. The water-level of the canal is almost coincident with that of the Baltic. So that on 340 days in the year the sluices can remain open, and the lock-gates into the Elbe can be opened daily at certain states of the tide; the water in the canal is to be at one uniform level throughout.

In consequence of the advanced state of the works it seems probable that the undertaking may be formally opened for traffic at the period originally contemplated, in the summer of 1895. Steamers will be permitted to propel themselves at a mean speed of about six miles an hour, and sailing vessels and barges will be towed in train through the canal by steam-tugs provided for this purpose.

Herr Beseke presents us with most exhaustive statistics showing the saving in time caused by the use of the canal as contrasted with the dangerous passage round the coast of Denmark, and a wreck chart of the entrance of the Baltic serves as an effective object-lesson of the value to navigation of this new sea-way.

In the concluding chapters we find most ample details of the volume of Baltic commerce and of the tonnage engaged therein, both in the form of steamers and sailing vessels, and excellent diagrams and charts have been specially prepared by the author to render these facts readily intelligible to the public. Nor does Herr Beseke omit to treat of the industrial value of these works and of their importance to the Fatherland, both from the military and naval aspects; in fact their political significance is shown to be enormous.

The volume contains a mass of well-digested information upon an undertaking concerning which but little has hitherto been heard in this country, but which is destined to exert a powerful influence upon the commerce of the states bordering upon the Baltic.

OUR BOOK SHELF.

Laws and Properties of Matter. By R. T. Glazebrook, M.A., F.R.S. (London: Kegan Paul, Trench, Trübner and Co., 1893.)

THIS is the latest addition to the manuals on "Modern Science" which are appearing under the direction of Sir John Lubbock. It is concerned with the meaning of the terms applied to matter, and with the principal properties which matter possesses, and contains chapters upon units of measurement, force and motion, work and energy, the forms of matter and of energy, and upon the properties of solids, liquids, and gases.

The book is an excellent introduction to the study of the physical properties of substances, and meets the main difficulty of the beginner by supplying him with sound ideas on the ground-work of his subject. It is indeed a matter for regret that there are so few similar books on other branches of science.

Although the properties discussed are almost entirely mechanical or physical, the author occasionally touches upon the subject matter of chemistry, and here the chemical reader may perhaps be puzzled to find the term "molecule" applied in cases where he has been taught to use the term "atom." The molecular weights given on p. 184, for example, are the ordinary atomic weights of the chemist. It is impossible, however, to correctly discuss even such chemical phenomena as are given in the book, without employing the conception of atom as well as that of molecule. Thus on p. 183 it is stated that "by adding to each molecule of carbonic oxide a second molecule of oxygen we get carbonic acid." This conclusion is not in harmony with Avogadro's hypothesis, for carbonic oxide unites with half its volume of oxygen to form carbonic acid.

The value 411° is much higher than those recently obtained for the critical temperature of water. On p. 19 "dynes in a given mass" should be "dynes in a given weight." The formulæ on pp. 164 and 180 are not correctly printed. J. W. R.

The Partition of Africa. By J. Scott Keltie. (London: Edward Stanford, 1893.)

THE author of this book does not wish it to be regarded as a contribution either to the geography of Africa or to the history of African exploration. His object has been to present "a brief connected narrative of the remarkable events which, during the last eight years, have led to the partition of the bulk of Africa among certain of the powers of Europe." In carrying out this purpose, Mr. Keltie displays wide knowledge, sound judgment, and an admirable power of lucid and effective exposition. The details of his narrative do not come within the scope of NATURE, but we may note that in his occasional references to the scientific aspects of the subject he invariably gives evidence of a thorough grasp of the principles which can alone be of vital service in the study of geography. This is especially true of a luminous and interesting chapter on "the economic value of Africa." The importance of the work is greatly increased by a large number of carefully-selected and well-executed maps.

Forest Tithes, and other Studies from Nature. By a Son of the Marshes. Edited by J. A. Owen. (London: Smith, Elder, and Co., 1893.)

BY "forest tithes" are meant the quantities of food secured at the expense of rural folk by wild creatures of the moorlands. The subject is an attractive one, and in dealing with it the author of this little volume presents many bright and lively sketches of animal life. The essays on other subjects are in their own way not less pleasant. They all display an ardent love of nature and a remarkable power of minute and accurate observation—qualities which have won for "a Son of the Marshes" a place of his own among the popular writers of the day. Some of the articles have already appeared in various publications; others are now printed for the first time.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Locusts at Great Elevations.

THE following account of the occurrence of swarms of locusts at great elevations in the Himalaya, and these stripping birch trees, is from a privately printed record of an expedition to the north-east of Kinchinjunga, in 1891, by Mr. White, the British resident in Sikkim. That flights of locusts are carried from the plains of India up to great heights in the Himalaya is a well-known fact; but not, I think, in the numbers nor with the results to birch or other forest trees here recorded.

The Camp, April. J. D. HOOKER.

"On July 19, 1891, I crossed the Lunglala Pass, 17,400 feet . . . . On the Pass I saw the locusts that had infested Darjeeling, for the first time, though subsequently I saw them as high as 18,000 feet, where they were dying in the snow. It will be remembered that this was the year of the great plague of locusts in Malie. I heard that they had penetrated even into Tibet. On the 21st I came down as far as Tangu, 12,750 feet, where the locusts were in swarms and dying in thousands. The only plants they seemed to care about were the birches, and these they stripped bare."

The Sandgate Landslip.

AS I have just returned from Folkestone, and have had opportunities for observing the recent "landslip" at Sandgate, perhaps a note on it may be of some interest to readers of NATURE, as I do not think the explanation suggested by Mr. Blake in NATURE (vol. xlvii. p. 467) is altogether applicable to the present instance.

So far as I could see from a careful examination of the exposures, there is no trace of any movement of the solid rocks of the cliff, as these are nowhere exposed in the fissures that have been formed by the earth-movements; and my impression from all that I saw is that the "slip" has been entirely confined to the débris which has accumulated in past ages against the flank of the escarpment. On referring to the four types of Bergstürze or landslips described by Prof. A. Heim, of Zürich, some years ago in a monograph, which was summarised (with additions) by myself in the *Geological Magazine* (Decade II., vol. x. p. 160 *et seq.*), it is not difficult to identify the Sandgate incident with the first class of such phenomena, to which Prof. Heim gives the name "Schuttrutschung"; that is to say, a *slide* or *push* of an accumulation of débris (Schutt). Such accumulations often in mountain regions occur as lateral moraines or as talus; and in my paper on the origin of valley lakes (*Quar. Jour. Geol. Soc.*, vol. xxxix., February, 1883) I have attempted to show how such masses play an important part in the formation of some lakes. The Sandgate phenomenon I take to be no more than a magnified instance of what occurs in many a clayey railway-cutting, as railway-engineers know too well. There seems to be no occasion for importing the notion of "faulting" of the rocks themselves into the question. Still less rational is the notion that vibrations due to the blowing-up of one or two ships lately had anything to do with the catastrophe. The most elementary principles of mechanics explain it completely.

A mass of rock-fragments and clayey material, such as may constitute a "scree," acquires in time a certain amount of coherency from the oxidation of the irony constituents, or from the solution and redeposition of carbonate of lime (where the materials are calcareous) by carbonated atmospheric waters percolating the mass, or from both of these causes. If the mass is fairly drained internally it may retain its stable condition for any length of time, and be mistaken for a part of the solid geotectony of the district, though in cases where the materials are largely composed of decomposable silicates, it is evident that there is a tendency for the proportion of the fine slippery clay-material in the mass to increase. The consequence may be (and often is) that there is a tendency in the whole mass to settle down under the force of gravitation, and so a slow preliminary differential movement often goes on for years, before some new factor is introduced to precipitate the disaster. There can scarcely be any doubt that the new factor in this case was the excessive rainfall of last February, and the want of sufficient under-draining to carry away the water, which entered the mass of partly-compacted débris from above. A small lateral valley parallel with the general line of the escarpment had no doubt served as a catchment agent for much of this water. This supposition is borne out by the facts (1) that further to the east, where a land-drain was laid some years ago, the mass below it remained stable; (2) that above the western end of the "slip" the military hospital suffered no damage, the stability of its base being doubtless due to the complete under-draining of the site, which, as my kind friend and host Colonel Cranmer Byng informed me, was carried out before the hospital was built. It is probable, however, that at the point of maximum movement the springs from the beds which form the plateau above had much to do with the water-logging and consequent diminution of the internal friction of the débris which moved, and that the action of those springs was exceptional or excessive in the early part of this year, owing to the rise of the water-line in the ground at the back of the escarpment.

I have talked the matter over with Mr. Topley, who is an expert on all matters of Wealden stratigraphy, and he agrees generally with me as to the real nature of the phenomenon. There is one obvious and only preventive against its recurrence.

Wellington College, Berks, April 15. A. IRVING.

"Roche's Limit."

I MUST thank your correspondent G. R. for correcting my carelessness in giving Roche's limit round the sun as about a tenth of the earth's distance, instead of about a ninetieth as it really is.

If R is the radius and D the density of a spherical planet, and d the density of the tidally disturbed and infinitesimal satellite, moving in a circular orbit so as always to present the same face to the planet, then the distance at which the satellite is on the point of being broken up by the tidal forces is $2 \cdot 44 \mathrm{R} \times (\mathrm{D}/d)^{\frac{1}{3}}$.[1] This is Roche's limit, and the formula is correctly stated by G. R.

The mean density of Jupiter is about one third greater than that of water, and it does not seem unreasonable to suppose that the density of the fifth satellite may be as low as 2. This would bring the limit to $2 \cdot 13$ R.

Any plausible hypothesis as to the density of the stones forming Saturn's rings will no doubt bring the limit somewhat inside the outer edge of the rings.

I must plead guilty to not having made these numerical estimates whilst writing my review of Mr. See's paper. However, it still seems to me that the coincidences which I there noted are very remarkable.

The simple illustration by which G. R. obtains a fair approximation to Roche's limit is very interesting.

The satellite is replaced by two small spheres of density d and radius r, touching one another, in line with the large sphere of density D and radius R. Suppose that when the point of contact is distant c from the centre of the large sphere, the small spheres are on the point of being pulled apart; then c is the approximation to Roche's limit. G. R.'s condition is that the excess of the attraction of the large sphere on the nearer small one above the attraction on the further one is equal to the attraction between the small ones. In algebraical language this becomes

$$\tfrac{4}{3}\pi \mathrm{D}\mathrm{R}^3 . \tfrac{4}{3}\pi d r^3 \left\{ \frac{1}{(c-r)^2} - \frac{1}{(c+r)^2} \right\} = \left(\tfrac{4}{3}\pi d r^3\right)^2 . \frac{1}{4r^2}.$$

Whence

$$\frac{(c^2 - r^2)^2}{c} = 16\mathrm{R}^3 . \frac{\mathrm{D}}{d}.$$

Treating r as very small we have $c = 2 \cdot 52 \mathrm{R} \times (\mathrm{D}/d)^{\frac{1}{3}}$.

If the spheres r are not very small, if $\mathrm{D} = d$, and if R be taken as unit of length, the equation for c becomes

$$c^4 - 2c^2r^2 - 16c + r^4 = 0.$$

This quartic determines the approximate limit when the satellite is not infinitely small.

I shall now use this equation to find what size we must attri-

[1] "La figure d'une masse fluide soumise à l'attraction d'un point éloigné." E. Roche. *Acad. des Sci. de Montpelier*, vol. i. (1847-50), p. 243.

bute to the small spheres, so that all three spheres may touch one another. They touch when $c = 1 + 2r$; whence we get

$$9r^4 + 24r^3 + 22r^2 - 24r - 15 = 0,$$

the solution of which is ·85078.

Hence if the smaller spheres have their radii ·85078 of the large one, they are all three in contact, and there is no pressure between the small ones, when they revolve with proper orbital angular velocity. Now the analogue of this solution in Roche's problem is very interesting. The problem is to find the relative sizes of planet and satellite, so that where the satellite is in limiting equilibrium the two bodies shall just touch. The solution will give a fair approximation to that hour-glass figure of equilibrium of rotating fluid, which I have treated otherwise in a paper in the Philosophical Transactions (vol. clxxxviii. A., p. 379). The solution would be improved, although complicated, by allowing the larger body to be also deformed.

Unfortunately the solution requires the tabulation of several functions depending on elliptic integrals. Roche made, but did not publish, tables of certain integrals, which he used for obtaining his results. It appears that the problem to which I refer did not occur to him.

Some years ago I began the computations necessary for this solution, but as it appeared to be a much more laborious task than I had anticipated, I have put the work aside until I should find leisure to attack the problem again. G. H. Darwin.

April 10.

The Afterglows and Bishop's Ring.

I agree with your correspondents (pp. 101 and 127) that there has been a marked increase in the amount of dust in the upper regions of the atmosphere within the last few months, as evidenced by sky phenomena.

I did not notice the sunset of November 27, and it was not till the next morning I observed any increase in the dust phenomena here. About sunrise on the 28th "Bishop's Ring" was very conspicuous for the first time for a considerable period, as also were the whitish wisps in and near it, very similar to those forming such a noticeable feature of the Krakatão sunsets; but I have never again seen them so small and definite as when those sunsets first took place. The sunset of that day (November 28) was a magnificent and striking one, with a very deep pink glow. On the 30th there was a somewhat definite bright segment below the rosy glow, at first a dull buff, and then orange. This segment was a very striking feature of the earlier Krakatão sunsets, but I have rarely seen it since till that day. I noticed it again on December 4. The wisps continued to be very conspicuous up to December 13, after which date they gradually grew less so, and have now disappeared altogether.

After the middle of December I was travelling in Portugal, the Canaries, and Spain. The segment was invisible—or at any rate not a noticeable feature—after December 19 to January 30; but most of the time I was not favourably situated for seeing it on account of hills. From the last-mentioned date to February 11 (during which time I was in the neighbourhood of the Straits of Gibraltar) the sunsets—generally on a cloudless sky—were very striking, and almost nightly the orange segment was very bright and definite, though I think not quite so definite in outline as in the Krakatão sunsets, but it reminded me much of them. As I had not been in that locality before, I do not know whether such sunsets are common there, or whether the phenomena were due entirely to a general accession of dust.

Since returning to England on February 14, the segment has sometimes been visible, though much less striking than in Spain.

"Bishop's Ring" still continues very conspicuous about sunset. I have not seen it of late years when the sun has had any considerable altitude, except on the 18th ult., from 1.30 to 3.30 p.m.; I was then in Teesdale at from 1300 to 1700 feet above sea-level; it was quite plain when the sun was behind a cloud, and visible even with the sun free from clouds. It has never ceased to be visible at about sunrise and sunset since November, 1883, although at times very faint. Has it always occurred when the sun is near the horizon, and is it only because attention was called to it by its remarkable vividness at the time of the Krakatão sunsets that one has been able to see it ever since, though never before? Unlike Mr. S. E. Bishop I always see a certain amount of red in the outer margin; though in the late accession to its conspicuousness the red has been very dull, rather to be called dull brown than red. This has also been the case at times before.

One other feature of the Krakatão sunsets has occasionally been visible of late in this country, namely, the second pink glow in the western sky. This was much more striking in Teneriffe, though still much fainter than in the Krakatão sunsets.

It would appear that if this dust is the same as that seen at Honolulu, it took six weeks to get from there to Dublin and Sunderland, while the Krakatão dust took two months in reaching the south of England from Honolulu.

Sunderland, April 10. T. W. Backhouse.

Thunderstorms and Auroral Phenomena.

I am residing in tropical Queensland, lat. 21° S., and consequently am not likely to see any auroral phenomena, particularly in the middle of our hot and rainy season; but last night between 8 and 9 P.M there occurred the following remarkable appearances, which were seen by me and several others.

There was a sharp thunderstorm with incessant lightning visible on the southern horizon, occupying a width of 10° and an altitude of from 5° to 10° above the horizon, probably from 80 to 100 miles off.

But for the distant thunderclouds the sky was clear and starlight, with a few light cirrhus clouds drifting before the north wind.

I was sitting on the lawn watching the distant flashes, when suddenly a patch or cloud of rosy light—5° to 6° in diameter—rose up from above the thunderstorm and mounted upwards, disappearing at an elevation of from 40°–45°. There were about twenty to twenty-five of these patches in the course of half an hour, sometimes three or four in quick succession; they took from one to two seconds to mount, and were not associated with any particular flash; the rosy colour contrasted strangely with the silvery light of Nubecula Major just above. There were also occasional streamers, sometimes bifurcated, of 2° in breadth, which shot up in the same way as the auroral streamers, which I have seen both in the arctic and antarctic zones.

Auroral phenomena are known to be electrical manifestations, but here were the same phenomena exhibited in connection with a thunderstorm in the tropics. Thinking this phase of electrical action worthy of note, I send you this account and enclose my card. J. Ewen Davidson.

Branscombe, Mackay, Queensland,
February 5th.

P.S.—The thunderstorm, patches of light, and streamers were distinctly *connected*; it was not a case of an ordinary aurora, with a thunderstorm interposed.

Fossil Floras and Climate.

Sir William Dawson demonstrates that the plants of the cretaceous and tertiary series of Canada prove that the temperature of Greenland during the tertiary period was mild but not subtropical. That is sufficiently extraordinary, but geologists prefer, with strange inconsistency, the more astonishing contrast between Heer's arctic miocene palms and the glacial period. The fact is that these floras, comprising a few large-leaved evergreens and relatively tender ferns and coniferæ, are not normal in such high latitudes, but confined to localities which might have been stations on the north coast of a warm Atlantic Ocean. Therefore they perhaps require nothing more prodigious than the circulation of a gulf stream in an Atlantic isolated from the Arctic Ocean, a probable state of things at that time. At all events tertiary plants collected from near the Equator negative any generally enhanced temperature.

This applies solely to the tertiary period, when many actually living species of plants were in existence. As we recede in time species become more strange and extinct, and likely to mislead. No wise person would define, for instance, from surviving cycads the climatic conditions they may have endured when as common and widely diffused as blackberries are to-day. Even estimates based on such a group as Gleichenia may be quite inapplicable when they sustained the *rôle* now usurped by the bracken.

Sir William Dawson is aware that with even the best preserved fossil leaves, and with access to the most complete herbaria in the world, half-a-dozen different conclusions may be come to in

succession; while single and imperfect specimens are mere pitfalls. No imperfect or indistinct leaves, unless they possess exceptional characters, should be named, since however faithfully described or figured, they are simply confusing.

J. Starkie Gardner.

WILD SPAIN.[1]

THERE seems to be no limit in these days to the demand for books on popular natural history, especially when they combine a certain amount of science with a sporting element. The present volume, in which the authors endeavour to describe Spain from "a point of view hitherto almost unoccupied, that of the sportsman-naturalist," excellently illustrated as it is, will, no doubt, attract a host of readers, for it deserves to do so. One of the joint authors, Mr. Abel Chapman is already known to us as a writer on the bird-life of the Scotch Borders, and as an ornithologist who has laboured very successfully on the birds of Spain. His coadjutor, Mr. Walter Buck, who is resident at Jerez, has long devoted himself to the exploration of the lower valley of the Guadalquivir and the bordering Sierras—the most interesting districts of the whole peninsula.

Although the larger mammals of Spain are by no means neglected, and even such extraneous subjects as corn, wine, oil, brigands and gypsies are cursorily treated of, "Wild Life in Spain" is emphatically a "bird-book." After their digressions on other points the authors return to their feathered favourites with a zest which shows that the study of the bird-life of the peninsula, combined no doubt with an ardent love of "la chasse," was the primary object of their wanderings.

In the fauna of Wild Spain the abundance of the larger birds of prey forms a very prominent feature, and several chapters are well devoted to this part of the subject. Almost all the finest and largest Raptors of the European ornis are to be met with in Spain. To the ornithologist, who in these latter days may search the greater part of "Wild Britain" without finding anything more exciting than a stray kestrel or a fugitive sparrowhawk, this superabundance of the larger Falconidæ must prove a great attraction. Eagle-shooting, which would be a fearful crime in England, is allowable, if not praiseworthy, in the Spanish peninsula, and even an occasional vulture may be killed without much harm being done. Moreover Spain is fortunate in possessing an eagle of its own, called by modern naturalists *Aquila adalberti*, which is in fact a local form of the Imperial eagle of South-eastern Europe. But the Adalbert's eagle is remarkable as showing several successive stages of plumage which do not appear to occur in its near ally. On these we have much information in the present volume from actual experience, which seems to prove that the Spanish Imperial eagle breeds indiscriminately in its youthful and adult liveries, birds in fully adult plumage having been found paired with others in the younger forms of dress. Besides eight or nine eagles two large vultures are abundant in the south of Spain, and the celebrated Lammergeier of the Alps known to the Andalucians by the appropriate name of "*Quebranta huesos*" or "bone-snatcher" is likewise still to be met with. How the eyries of this giant bird, situated in the mountains eastward of Jerez were visited and ransacked is told to us in two attractive chapters. As the breeding-season of the Lammergeier begins in January, when the Sierras are still under snow and the weather is inclined to be severe, such an expedition is by no means free from inconveniences.

Even in wild Spain, we regret to say, the Lammergeier is yearly decreasing in numbers. "A decade ago they were fairly numerous in the vast area of rock-mountains which stretch between Granada and Jaen. To-day a week may be spent in that district without even so much as a distant view of this grand bird. The reason is unquestionably the use of poison, which is laid out broadcast by the goat-herds for the special benefit of wolves, but which is equally fatal to the Lammergeiers."

Another leading feature in the Spanish ornis is the Great Bustard, still abundant in Andalucia "on those vast stretches of silent corn-lands which form its home." "Big days with bustard," the various modes of its *chasse* and the principal features of its life are well described in "Wild Spain." It is curious that the authors do not seem to have been able to ascertain positively whether this bird is monogamous or polygamous. Even during the pairing season each band of bustards is composed of mixed sexes, the females preponderating, until the latter skulk off to perform the duties of incubation, and leave the males all together in separate packs. Bustard-shooting must indeed be glorious sport. Oh, that Salisbury

Male Great Bustard, showing off.

Plain could be restocked with this now nearly extinct (English) bird!

Next to the bustard the flamingo is perhaps one of the most attractive objects to the explorer of the wilds of Andalucia. In some seasons flamingoes visit the marismas in enormous flocks; in other years they are extremely scarce. In 1883 Mr. Chapman found them abundant in the month of April, and searched the country over a large area systematically, in the hope of finding their breeding-places. The exact fashion in which this bird sits upon its nest had long been a matter of controversy, and it was hoped that this interesting point might now be definitely settled. But in April all efforts were unsuccessful—it was evident the birds had not yet begun to breed—and a smart attack of ague was the only result of splashing about from day to day in the mud and water, with a fierce sun beating down upon the ornithologist's head. In May, however, during an

[1] "Wild Spain (España agreste), Records of Sport with Rifle, Rod, and Gun, Natural History and Exploration." By Abel Chapman, F.Z.S., and Walter J. Buck, C.M.Z.S., of Jerez. With 174 illustrations, mostly by the authors. (London: Gurney and Jackson, 1893.)

exploration of certain bird-islets lying off the shore of the marisma, success was at length obtained. On a low mud-island was found a "perfect mass of nests," and scattered round the main colony were numerous single nests raised above the water-level. From a distance of about seventy yards the sitting birds were observed most distinctly. "The long red legs doubled under their bodies, the knees (*scribe*, heels) projecting as far as or beyond the tail, and their graceful necks neatly curled away among their back-feathers, with the heads resting on their breasts—all these points were unmistakable." The problem was thus solved, for it had been asserted by previous authorities that the sitting flamingo, unlike other birds, straddles across its elevated nest, leaving its long legs dangling down on each side! It is only fair, however, to add that the true mode of the incubation of the flamingo has also been witnessed since, in the case of the North American species (*Phœnicopterus roseus*), by Sir Henry Blake, in the West Indian island of Abaco (see *Nineteenth Century*, December, 1887). Sir Henry has fully confirmed the accuracy of Mr. Chapman's observations.

Another curious discovery which we owe to the energy of Mr. Chapman is the existence of wild camels living and breeding in the "Bœtican Wilderness." The statement that camels were roaming about and reproducing their species in Europe at first met with much unbelief and even ridicule. There can be no doubt, however, on the subject. The camels were introduced from the Canaries in 1833, and for some years used as beasts of burden in the province of Cadiz. At the present time some stray descendants of these camels live and flourish in the marisma in a "wholly wild state," and are "practically ownerless."

Did space permit, we could well give further "elegant extracts" from this interesting volume, which is replete with information on the inhabitants of "Wild Spain," and their manners and customs. The numerous plates and smaller illustrations in the text are mostly excellent, and add greatly to the attractions of the work. We might, however, wonder that greater accuracy has not been secured as regards the spelling of some of the scientific names, especially when we are told that Mr. Howard Saunders's experienced eye has "gone through the proof-sheets. For example, *Haliäetus* is misprinted "*Haliœetus*," *Aëdon*, "*Ædon*," and *Rhopalocera*, "*Rhodopalocera*." Nor is it correct to call an Arabian camel (*Camelus dromedarius*) a "Bactrian" (*i.e. C. bactrianus*). It is also now well known that the ichneumon of Spain is the same as the Algerian and Egyptian species (*i.e. Herpestes ichneumon*). It should therefore be no longer called *Herpestes widdringtoni*.

Flamingoes on their Nests.

NOTES.

The conditions under which the total solar eclipse on Sunday was observed seem, on the whole, to have been favourable. According to a telegram from Ceara, the clouds at Para Cura—where the British expedition in charge of Mr. A. Taylor was stationed—were heavy before contact, but afterwards dispersed, leaving a clear space for observation during totality. The photographs were believed to be satisfactory. The eclipse was seen at Bathurst, in West Africa, "in perfectly clear

weather," and no doubt was entertained there that the British expedition under Prof. Thorpe, at Fundium, on the Salum River, had been equally fortunate. M. Bigourdan, one of the astronomers sent by the Paris Observatory to observe the eclipse in Senegal, has telegraphed to M. Tisserand, the Director: "Foggy sky; observed the four contacts; Vulcan not seen." Prof. Pickering has telegraphed to the *New York Herald* that the atmospheric conditions prevailing at Minasaris during the solar eclipse were perfect, and that the results of his observations were very satisfactory. He observed four streamers proceeding from the corona, two of which stretched over a distance of more than 435,000 miles. Several dark rifts were also visible extending directly westward from the moon's limb to the utmost limit of the corona. Several solar prominences attained great distinctness and brilliancy. During the eclipse the surface of the moon appeared almost of an inky blackness, by contrast with the dazzling brightness of the inner corona. The observations showed very conclusively that the present condition of the sun is one of great disturbance. The corona was whitish rather than red in tint. Many satisfactory photographs were taken.

THE first Royal Society soirée of the present season will be held at Burlington House on Wednesday, May 10.

THE International Sanitary Conference closed its proceedings on Friday last with the signing of a provisional convention by the representatives of Germany, Austria-Hungary, Belgium, France, Italy, Luxembourg, Montenegro, the Netherlands, Russia, and Switzerland. The delegates of the other Powers accepted the convention *ad referendum*. The ratification is to take place in Berlin within six months. According to the Berlin correspondent of the *Times*, the convention is divided into two chief sections. The first contains the international preventive measures to be taken against cholera as regards passenger and goods traffic, as well as regulations for obviating a dislocation of trade in case of an epidemic. The second section deals with the question of sanitation at the mouths of the Danube.

A COMPLIMENTARY dinner was given by the Royal Meteorological Society, at Limmer's Hotel, on Saturday evening last, to Mr. Henry Perigal, in celebration of his 92nd birthday, and of the completion of forty years' service as treasurer. A number of friends from other societies with which Mr. Perigal is connected also joined in the dinner. The President, Dr. C. Theodore Williams, in proposing the toast of the evening, gave some interesting particulars of the Perigal family, tracing their history back to some time before the Norman Conquest. The family have been remarkable for longevity. Mr. Perigal's father, who was 99¼ years of age when he died, was one of thirteen children, nine of whom attained respectively their 64th, 67th, 77th, 80th, 88th, 90th, 94th, 97th, and 100th year—the last five averaging 93 years 100 days. Their father and mother died in 1824, the former being nearly 90 and the latter upwards of 80 years of age. Mr. Henry Perigal was the eldest of six children, one of whom lived to the age of 85, and the youngest, Mr. Frederick Perigal, now in his 82nd year, was present at the dinner. Mr. Perigal briefly responded to the toast, thanking all present for their congratulations and kind wishes.

THE "Universitas Jurievensis," formerly known as Dorpat University, celebrated the centenary of the birth of the astronomer, Wilhelmus Struve, who was a professor in the University, on Saturday last, the 15th inst., by an oration delivered in the large hall of the institution.

THE Council of the Marine Biological Association has decided that in future a table in the Plymouth Laboratory may be rented for a single week, at a cost of thirty shillings. It is hoped that advantage will be taken of this arrangement in the shorter vacations. The other charges (£5 for a month, £25 for six months, £40 for a year) remain the same.

THE Council of the Durham College of Science have addressed to the governors and other friends of the institution an urgent appeal for the means of relieving the college from its financial difficulties. During the last three or four years the college income has nearly balanced the expenditure, but this has been brought about only "by the teaching staff placing the financial interests of the institution in front of their own, sometimes going the length of surrendering their fees when it has not been obvious how they were to be paid out of the funds available, and in many cases providing, at their own expense, apparatus or assistance which, under ordinary circumstances, should have been supplied by the college." This is very creditable to the teaching staff, but it is absurd that such sacrifices should have to be made by the officers of an institution established and maintained for the benefit of the people of a great and wealthy district. When the facts about the matter are generally known, the authorities of the college ought to have little difficulty in obtaining what funds may be necessary for the full development of its work.

ANOTHER terrible earthquake occurred in Zante at seven o'clock on Monday morning. It was even more violent than the earthquake by which so much damage was done in February. Other shocks were afterwards felt. The town of Zante was almost destroyed, the church of St. Dionysius, the theatre, and the prefecture being among the buildings now in ruins. According to the accounts telegraphed on Tuesday, seventeen persons were killed in the town, and many injured. The villages in the island have not generally suffered so severely, but one village, Gaetani, has been totally destroyed, and there has been some loss of life. A correspondent of the *Times*, telegraphing from Patras, says that at the time of the principal shock the sea receded several feet from the shore, and that a severe shock was felt at Patras, at Pyrgos, and on the western shore of the Peloponnesus.

DURING the past week several depressions have traversed the extreme northern parts of our islands and Scandinavia, causing unsettled weather in those parts, which on Sunday extended southwards, and on the following day disturbed weather became fairly general over the United Kingdom. The rainfall in Ireland and Scotland was somewhat heavy, but in the southern districts the fall was slight, and at several stations no rain fell. In the neighbourhood of London the drought had lasted thirty days, a period which has been unparalleled at any season of the year during the last half century. The day temperatures have varied considerably in different parts, the maxima on several days exceeding 60° and even reaching 67° in the midland and south-eastern districts, while in the north they have ranged from 40° to 50°. Sharp frosts have occurred during several nights, the readings on the 14th being from 5° to 8° below the freezing point in the shade over central England, and falling to 19° on the ground. On Monday an anticyclone lay over the North Sea, again bringing fine weather to the south-eastern portion of England, but on the following day depressions were approaching our north-west coasts, and a gale was blowing in the extreme north, while the general conditions were of a more unsettled type than for some considerable time past. During the week ended the 15th inst. there was a considerable decrease in bright sunshine, but still it exceeded the mean in nearly all districts.

THE Maryland State Weather Service publishes a monthly report in connection with the U.S. Weather Bureau. That for March contains an interesting article by Prof. W. B.

Clark, of the Johns Hopkins University, on the surface configuration of Maryland. The state is divided into three districts: the Appalachian Region, the Piedmont Plateau, and the Coastal Plain The inland border of the Coastal Plain marks the head of navigation, above which the inclinations of the valleys rise more steeply. This boundary is called the "Fall-line"; along it the larger cities of the Atlantic seaboard have grown up, and it marks out the leading highways of trade which connect the north and south. The prolongation of these three regions through other states is pointed out, and attention is directed to their importance as affecting temperature, rainfall, and the direction of the winds.

The Berlin Academy has recently made the following grants:—£50 to Dr. Wulf, of Schwerin, for prosecution of his crystallographic researches; £30 to Prof. Taschenberg, of Halle, for publication of his *Bibliotheca zoologica*; £50 to Dr. Herz, of Vienna, for carrying further the reduction of the observations at the Kuffner Astronomical Observatory; £175 to Prof. Selenka, of Erlangen, for a journey to Borneo and Malacca to investigate the development of apes, and especially the orang; and £25 to Prof. Keibel, of Freiburg, for his researches on the development-history of the pig.

The relations of the universities to the county councils in respect to technical education will be discussed to-day and to-morrow at a conference which will meet at Cambridge in accordance with arrangements made by the Cambridge University Extension Syndicate. The conference will be attended by representatives of county councils and universities, and by other persons interested in the subject. Cambridge has during the last year provided courses of lectures on various scientific subjects coming within the scope of the Technical Instruction Acts for eleven County Councils as well as for the technical education committees of other local authorities. A large part of the work done has consisted of simple scientific teaching in villages and small towns, and the attempt thus to bring the universities into closer relation with rural districts has naturally led to results of considerable interest and novelty. The results of such work and the most effective way of making progress in the future will be among the subjects discussed at the conference. Another item will be the scheme for systematic instruction in agricultural science at the university, devised by Prof. Liveing and others in cooperation with several of the county councils.

The Cambridge University Extension authorities have already announced as part of the programme of their summer meeting to be held in Cambridge next autumn five courses of practical work in science in the university laboratories and museums, the subjects selected being chemistry, electricity, botany, physiology, and geology. As, however, the date of the summer meeting, July 29 to August 26, is too early for many teachers in elementary schools whose holidays fall during harvest time, arrangements have also been made for two courses in agricultural chemistry, specially adapted to meet the requirements of teachers sent with scholarships by their respective county councils. Each course will extend from August 25 to September 12 inclusive, and will thus include sixteen working days, on each of which several hours' work in the university laboratory will be provided. One course—conducted by Mr. Fenton, one of the university demonstrators—is intended for students who have done little or no laboratory work, but have acquired a knowledge of theoretical chemistry, and will be similar to the course given last year and attended by about 120 county council scholars. The other course—conducted by Mr. R. H. Adie, one of the Cambridge Extension lecturers—will be more advanced in character, and will be adapted to students who went through last year's course with credit, or have done similar work elsewhere. Accommodation for 120 students can be provided at these two courses.

Last month a stone, which is valued at 17,000 rupees, was discovered at the Burma ruby mines. According to the *Pioneer Mail*, this is the most valuable ruby which has come to light for some considerable time past.

M. Édouard Branly gives a further account of his experiments on the loss of the electrical charge of bodies in diffuse light and in darkness, in this week's *Comptes Rendus*. He finds that a disc of polished aluminium, if it is experimented on a few days after being polished, behaves like most other metals; *i.e.* it slowly loses its charge, and the loss is approximately equal for the two kinds of electricity and independent of the kind of light to which it is exposed. If the disc has been freshly polished, however, even in diffuse light the loss is rapid, and is only slightly diminished by surrounding it by orange glass, thus showing the loss not to be due, to any great extent, to the rays at the more refrangible end of the spectrum.

In the current number of the *American Journal of Science* there is a paper by Mr. I. Pupin, describing a method of obtaining alternating currents of constant and easily-determined frequency. For this purpose he uses a small transformer, whose primary circuit contains an interrupter of peculiar design. This consists of a stiff brass wire, stretched between the pole pieces of two permanent horse-shoe magnets, and carrying at its middle point a short amalgamated copper wire. At every vibration this copper wire dips into a mercury cup and closes the circuit of a battery; the repulsion between the current in the wire and the magnets serving to keep up the vibrations. The tension, which can be adjusted without stopping the vibrations, is altered until the wire is in unison with a tuning-fork of known pitch. In order to diminish the intensity of the harmonics which are present when the current is interrupted in this way, the primary of the transformer is joined in series with another coil, having a movable iron core, and in parallel with a condenser of variable capacity. The capacity and self-induction of the circuit are by these means altered till the natural period of the circuit corresponds with the fundamental of the wire. The attainment of this condition is shown by the sparking at the break being a minimum. Under these circumstances the circuit acts as a resonator, and selects from the complex E.M.F. that harmonic with which it is in resonance, and strengthens it.

For some considerable time continuous records have been kept at Greenwich Observatory of the earth currents along two lines approximately at right angles. However, since the South London Electric Railway has been working, the records, except during a few hours of the night when the trains do not run, have been so disturbed as to be quite valueless. These disturbances show to what an extent the current, when there is no insulated return, strays, as the railway is nowhere within four miles of the Observatory. In order to continue the earth current records and if possible trace their connection with the disturbances of the earth's magnetism, Prof. Mascart has had two earth-current lines fitted with continuous recording galvanometers, placed in the Parc Saint-Maur Observatory, and has so selected his lines that one runs exactly north and south, and the other east and west. In addition to the above a continuous record is kept of the currents passing in an aerial circuit, which is at all parts insulated from the earth.

In the course of some investigations necessitating the elimination of small variations of atmospheric pressure, Dr. Carlo del Lungo constructed what appears to be a highly sensitive mercury barometer. As described in the *Rivista Scientifico-Industriale*, it consists of a vertical tube of 20 mm. bore and about a metre long, bent round at the bottom in the ordinary way, but having the open end closed by a steel cap screwed on to an iron collar attached to the tube. A long

capillary tube of 1 mm. bore is attached at right angles to the main tube a little above the bend, ending in an open vessel. The amount of mercury is so adjusted that there is a free meniscus about the middle of the capillary tube. Any slight increase in atmospheric pressure will then cause the main column to rise, and the necessary mercury will be withdrawn from the capillary. A fall of pressure will be indicated by a forward movement of the meniscus in the horizontal tube. Thus the rise and fall of the mercury in the main tube is exaggerated in the ratio of the sections of the tubes, in this case 400 : 1. Hence it is possible to observe a variation of $\frac{1}{100}$ mm. Should the variation of the pressure be so large as to drive the meniscus out of the tube altogether, it can be brought back by screwing the steel cylinder up or down. In spite of the errors introduced by variations of temperature and the faults due to capillary adhesion, variation of sectional area of the tube, and impurities in the mercury and the glass, the instrument appears to be well adapted to the observation of small fluctuations of pressure, such as the diurnal variation and the small and rapid oscillations peculiar to windy days. On one such occasion an amplitude of two or three centimetres was obtained in the course of two hours, during which an ordinary barometer remained perfectly steady, and a Richard barograph showed only a faintly waved line.

IF we may accept literally Sir Edward Braddon's glowing descriptions of gardens in Tasmania, that island ought to be the paradise of horticulturists. Speaking the other day before the Indian section of the Society of Arts, he said of the garden he himself cultivated there for ten years: "All the year through that garden had its charms of colour and perfume to lavish upon me; always there were life and growth in progress, and new delights unfolding themselves out of nature's bounteous lap." His monster pelargoniums, that stood from 3 to 4½ feet high, and had a circumference of 9 to 27 feet, were sources of increasing pride and pleasure to him, as they were of successive glories of flower. As for his fruit trees and vegetable garden, they yielded a never-failing supply of food for the table that in England, purchased of the greengrocer, would have cost about £100 a year. "Many another garden like unto mine is there," said Sir Edward, "in Tasmania and New Zealand, gardens in which all the fruits and flowers of the temperate zone flourish abundantly, and in which it is possible for a European to work all the year round without fear of sunstroke or frostbite." These panegyrics were uttered in the course of an address in which the speaker tried to persuade Anglo-Indians that after their term of service in the East they would find it pleasanter and more profitable to settle somewhere in Australasia than to return to England. The address is an interesting one, and may be read—with the discussion to which it gave rise—in the current number of the *Journal of the Society of Arts.*

THE Hornsey Local Board, Highgate, has set a good example to other Local Boards by organising an excellent museum of modern sanitary appliances. About two years ago it occurred to the Board that it might be well to bring together some specimens of the most improved fittings for the guidance of builders and others. Accordingly a suitable room was erected, and manufacturers were invited to send examples of their manufactures. In order to ensure the permanence of the museum it was stipulated that all articles deposited should become the property of the Board; and thus an important collection—which now occupies seven rooms—has been gradually formed. It is open free to the public on week days, and a good catalogue of the contents of the museum has just been issued.

MR. ROBERT SERVICE, of Maxwelltown, writing in the new number of *The Annals of Scottish Natural History*, says it is somewhat surprising, considering the untold myriads of voles that have overrun the sheep pastures in southern Scotland for a year or two past, that so few variations in colour have been reported. He himself has not seen any noteworthy aberration among those he has observed in peregrinating through their haunts, but the shepherds have reported an occasional pied example. Mr. Service has, however, a very strong impression that the "hill voles" are decidedly of a more smoky tint than those to be found in the lower lands among the hedges and plantations. The latter seem to develop a much ruddier colour on the fur along the back, and the general tone of gray seems much brighter than that of the voles that have ravaged the upland pastures.

MR. THOMAS STEEL continues in the *Victorian Naturalist* for February his remarks on some zoological gardens he has visited. The collection at Rundwick Park, Sydney, contains some very fair specimens of various kinds, especially among the large carnivora and the monkeys; but he thinks a visitor from abroad would be disappointed in the small number of indigenous animals. Melbourne and Adelaide seem to be better off in this respect. Of the Melbourne Gardens, as compared with those he has visited elsewhere, he has a high opinion. Nowhere has he seen more attention given to the rational housing and to the comfort of the animals.

OPPONENTS of the doctrine of evolution have often tried to support their view of the subject by reference to the supposed sudden appearance of metaspermic plants in the rocks of the Cretaceous period. In the *American Naturalist* for April Mr. Conway McMillan deals with this point in an article on "the probable physiognomy of the Cretaceous plant population." He undertakes to show, first, that the appearance of Cretaceous metaspermic plants is proved, by the fossils, not to have been sudden, but gradual, and consequently, in Cretaceous time, the general preponderance of plant-population was strongly coniferous, fern and cycadean; and second, that the conditions of Cretaceous time were such that the new and scattered metaspermic plants were placed under circumstances similar to those in which to-day variation is most rapid and plasticity is greatest for each species and even for every individual.

SOME interesting notes on alligator shooting in Trinidad are contributed by Mr. S. Devenish to the February number of the *Trinidad Field Naturalist's Club Magazine.* In Trinidad it is commonly believed that if any one attempts to touch an alligator's nest, he runs great risk of being attacked by the mother alligator, who is always on the watch to defend her progeny. While surveying on the left bank of the Caroni, Mr. Devenish came once upon one of these curious constructions, and so frightened were his eight men at his going to examine and demolish it, that they all ran away to a distance of at least twenty yards, warning him of the danger of the "Maman Caiman," which was sure to attack him. However, having beside his bowie knife at his side, his cutlass in hand, he prepared for defence, and quietly demolished with perfect immunity the large nest, in which he found a number of eggs. Of these a few were blown for his collection, and the rest left to hatch near a little fountain in his garden. After a few days the hatching took place, and it was as curious as interesting, says Mr. Devenish, "to see the little alligators, still adhering to the shells by their umbilical cords, briskly showing fight when approached, dragging the shell behind them and rushing with open jaws at anything presented to them and madly biting it."

THE Royal Dublin Society has published in its Proceedings a list of some of the Rotifera of Ireland, by Miss L. S. Glascott. The list is the result of research carried on from May to October in 1891. The number of rare and new species obtained during this short period seems to indicate that the

Rotifera are well represented in Ireland, and Miss Glascott has been induced to issue her list in the hope that it may lead other observers to study the group.

Dr. John Struthers contributes to the current number of the *Journal of Anatomy and Physiology* an important paper on the rudimentary hind-limb of a great fin-whale (*Balænoptera musculus*) in comparison with those of the humpback whale and the Greenland right-whale. His object is to determine the interpretation which should be given to the occurrence of a part apparently so rudimentary as a thigh-bone of about the size of a pigeon's egg in a great whale. He decides that the presence of the bone in fin-whales cannot be accounted for from the point of view of function, and that the bone must be regarded only as "a vestige." In the course of his inquiry Dr. Struthers has had occasion to note the need for caution in the attempt to find a functional explanation of the presence of rudimentary structures. "In endeavouring," he says, "to assign uses to rudimentary structures, we have to keep in view that such parts may in reality serve no purpose of functional utility, may be meaningless except as the products of decreasing heredity or as the incidents of variability, and that the parts attached to such structures may be but remnants, or may be adaptations acquired amid the surrounding activities."

The purification of water more especially for drinking purposes has assumed quite a different character since the introduction and application of the bacteriological methods now in vogue. Novel processes have in consequence been devised, whilst those already in use have received an altogether new interpretation. In two recently published papers further contributions are made to both these aspects of the subject. V. and A. Babes, in "Ueber ein Verfahren keimfreies Wasser zu gewinnen" (*Centralblatt für Bakteriologie*, July 30, 1892), describe a series of experiments which they have conducted on the removal of micro-organisms in water by means of alum. Some years ago Leeds made some investigations on this subject, and showed that by the addition of one-half grain of alum to a gallon of water the number of microbes in fifteen drops was reduced from 8100 to 80. This material has, moreover, been employed for the purification of water on a large scale in America, the amount used varying according to the water, from one-half to six grains per gallon of water. In the above paper the authors record the use of very much larger quantities of alum than Leeds, and in all cases after agitating the water with this material, they obtained an absolutely sterile liquid, although the water contained originally as many as 1200 microbes in about twenty-five drops. The number of bacteria in the sediment of a water shaken up with alum was also investigated, and was found to contain but a mere fraction of the organisms originally present. In the second paper, "Reinigung des Wassers durch Sedimentirung" (*Centralblatt für Bakteriologie*, February 8, 1893), Percy Frankland details some further investigations he has recently made on the purification of water by sedimentation. This author conducted a series of experiments some years ago on the removal of micro-organisms from water by means of agitation with different solid particles, both in the laboratory and as practically carried out during the softening of water by means of lime in Clark's process. In the present investigations attention is directed to the bacterial purification which takes place during the storeage of water on the large scale in reservoirs. The following experiment may be cited, showing the nature of the results obtained:—The Thames water before flowing into the reservoirs of one of the London water companies contained 1437 microbes per c.c. (about 25 drops); on passing out of the first reservoir there were 318 present; whilst after passing through the second reservoir only 177 were present in the c.c. Both Frank and Schlatter, the former for the river Spree, and the latter for the river Limmat at Zürich, have pointed out the reduction in the number of bacteria which is exhibited in the course of a river's flow, and the above results show clearly how important a factor is sedimentation in this process of purification.

A full report of the second session of the International Congress of Experimental Psychology, held in London in 1892, has been published by Messrs. Williams and Norgate.

A little book which seems likely to be of good service to young students of geometry has been published by Messrs. Macmillan and Co. It is called "Exercises in Euclid, Graduated and Systematized," and is by Mr. William Weeks, lecturer on geometry, St. Luke's Training College, Exeter. The examples are grouped in sets, each set bearing upon, and serving to impress, some fundamental fact or principle which is stated in larger type at the head of it. Thus the object of the book is to build up the pupil's knowledge, and to develop in him gradually the power to grapple successfully with difficult deductions.

Some remarkably interesting illustrations of the zoological results obtained by the naturalists on board H.M. Indian marine surveying steamer *Investigator* are being published. They consist of plates with brief explanations of the figures. We have received Part I. of "Fishes," by A. Alcock, and Part I. of "Crustaceans," by J. Wood-Mason. In the former there are seven plates; in the latter, five.

"A Dakota-English Dictionary" has been published by the U.S. Department of the Interior. It is an enlarged and improved version of a work prepared by a missionary, the Rev. S. R. Riggs, and published by the Smithsonian Institution in 1852. Mr. Riggs died in 1883, but had been able to get the new edition of his dictionary ready for the press. The task of editing his materials has been fulfilled by Mr. J. O. Dorsey, who has made a special study of the Siouan language, including the Dakota, since 1871.

A new mode of preparing hyponitrous acid, $H_2N_2O_2$, eminently suitable for demonstrating the existence of this interesting lowest acid of nitrogen in the lecture room, is described by Dr. Wilhelm Wislicenus in the current number of the *Berichte*. It will doubtless be remembered that hyponitrous acid was first prepared in the year 1871 by Divers, by reducing nitrates with sodium amalgam. Zorn subsequently showed that the molecular composition of the acid was most probably represented by the double formula $H_2N_2O_2$. He prepared the ethyl salt and found it to be a substance suitable for a determination of vapour density; the numbers obtained upon making a series of such vapour density determinations indicated that its molecular composition was $(C_2H_5)_2N_2O_2$. Several years ago Victor Meyer described an interesting reaction of hydroxylamine, NH_2OH. He showed that nitrous acid and hydroxylamine mutually decompose each other with production of water and nitrous oxide gas. $NH_2OH + HNO_2 = 2H_2O + N_2O$. It was further shown that when concentrated solutions of hydroxylamine sulphate and sodium nitrite are mixed a rise of temperature and a violent evolution of nitrous oxide occur. Dr. Wislicenus now shows that even very dilute solutions of sodium nitrite and hydroxylamine hydrochloride although cooled by ice slowly evolve nitrous oxide, eventually suffering complete mutual decomposition. The explanation of these reactions between hydroxylamine and nitrous acid has hitherto been unknown. It is now shown to be due to the fact that hyponitrous acid is produced as an unstable intermediate product.

$$NH_2 . OH + NO . OH = HO . N : N . OH + H_2O.$$

It is a well-known fact that hyponitrous acid readily breaks up into nitrous oxide and water, hence the explanation of Victor

Meyer's reaction is at once apparent. To prove the fact Dr. Wislicenus shows that the silver salt of hyponitrous acid may actually be obtained from the solution at a certain stage of the reaction, and the experiment forms the best method yet described of demonstrating the formation and properties of hyponitrous acid. There is always a considerable amount of hyponitrous acid present in the slowly-effervescing liquid obtained by mixing solutions of hydroxylamine sulphate and sodium nitrite at the ordinary temperature. Much more, however, is present for a few minutes when the liquid is warmed to 50–60°. At this temperature the decomposition is sufficiently rapid to cause somewhat energetic effervescence, but by the immediate addition of a solution of silver nitrate the greater portion of the hyponitrous acid can be fixed and precipitated in the form of the bright yellow stable silver salt, $Ag_2N_2O_2$. The yield of the finely divided precipitate is about ten grams for every hundred grams of hydroxylamine.

WHEN it is desired to demonstrate this mode of formation of hyponitrous acid upon the lecture table, solutions of about three grams of hydroxylamine sulphate and the equivalent quantity of sodium nitrite are previously and separately prepared. The total amount of solvent water should not exceed two hundred cubic centimetres. When the time arrives to perform the experiment the two solutions are mixed and a little of the resulting liquid immediately decanted into a test glass, silver nitrate solution added, and the fact pointed out that the resulting precipitate of nitrite and sulphate of silver is white. The vessel containing the main quantity of the liquid is then transferred to a water bath warmed to 50°, when a rapid evolution of gas at once commences. The issuing gas may rapidly be shown to answer to the properties of nitrous oxide by inserting a glowing splint, and almost immediately silver nitrate solution should be added to the liquid, when the beautiful bright yellow silver salt of hyponitrous acid is precipitated.

NOTES from the Marine Biological Laboratory, Plymouth.—Last week's captures include the Polychæta *Hyalinæcia tubicola* and *Amblyosyllis* (*Gattiola*) *spectabilis*; the Mollusca *Ovula patula* and *Loligo media* (136 mm. in length of mantle!); the Decapod Crustacea *Nika edulis*, *Ebalia Pennantii* and *Cranchii*; and the Tunicata *Clavelina lepadiformis*, *Archidistoma aggregatum* and *Perophora Listeri*. The "gelatinous alga" has now entirely replaced *Halosphæra viridis*, and both spherical and elongated forms are being taken in the townets in great profusion. A single specimen of the Cladoceran *Podon*, carrying embryos, has been taken for the first time this year. Among the many animals now breeding, the following have not previously been noticed: the Cephalopod *Loligo media*; the Leptostracan *Nebalia bipes*; the Schizopod *Macromysis flexuosa* (= *chamæleon*); the Macrura *Pandalus brevirostris* and *Hippolyte Cranchii*, and the Brachyuran *Porcellana longicornis*. The *Glaucothoë*-stage of *Pagurus* has also been taken.

THE additions to the Zoological Society's Gardens during the past week include a Black-bellied Weaver Bird (*Euplectes afer*), a Pin-tailed Whydah Bird (*Vidua principalis*), an Orange-cheeked Waxbill (*Estrelda melpoda*), two Common Waxbills (*Estrelda cinerea*) from West Africa, two Amaduvade Finches (*Estrelda amandava*), two Indian Silver-bills (*Munia malabarica*) from India, presented by Miss Herring; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, presented by Mr. H. H. Forsayth; four Red-backed Buzzards (*Buteo erythronotus*) from the Falkland Islands, two presented by Dr. Dale, and two presented by Mr. Vere Packe; three Upland Geese (*Bernicla magellanica*) from Patagonia, presented by Sir Roger T. Goldsworthy; a Herring Gull (*Larus argentatus*) British, presented by Mr. Thomas Owen; an Alexandrine Parrakeet (*Palæornis alexandri*) from India, presented by Mr. S. Hulme; a Banded-tailed Tree Snake (*Ahætulla liocercus*), a — Snake (*Dipsas cenchoa*) from Trinidad, presented by Messrs. Mole and Urich; six Green Tree-frogs (*Hyla arborea*) European, presented by the Rev. Clifford D. Fothergill; a Moorish Toad (*Bufo mauritanica*) from Tunis, a Banded-tailed Tree Snake (*Ahætulla liocercus*) from Trinidad, deposited; two Red Oven Birds (*Furnarius rufus*), a Melancholy Tyrant (*Tyranus melancholicus*) from the Argentine Republic, a white-eyebrowed Wood Swallow (*Artamus superciliosus*) from New South Wales, six Edible Frogs (*Rana esculenta*) European, purchased; a Gayal (*Bibos frontalis*, ♂) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE PHOTOGRAPHIC CHART OF THE HEAVENS.—M. Lœwy in *Comptes Rendus* (No. 13) for March 27 adds a few more words with regard to the scheme which he has suggested for determining the coordinates of the centres of the clichés. Without such a method as his, or at any rate one that has for its object the same end (that is, of shortening the work), it seems that the work of determining the positions of the chief stars will extend over some period. With 22,054 plates covering 169 cm. and corresponding to a portion of the sky 4°·7 square, the average number of stars up to the eleventh magnitude is estimated as 250. Now it is not necessarily certain that on all of these plates there will be stars whose positions are accurately known, and further, even if accurate places had once been obtained, our knowledge of their proper motions is not considered advanced enough to apply them in such an instance as this. Only the two following ways, then, seem to be left:—(1) To observe afresh with our meridian circles as many (say six) stars as will appear on each cliché and deduce their positions (thus eliminating proper motion), or (2) to adopt a system of triangulation, assuming we know the places of some of the more important position stars. M. Lœwy's method is based on the latter, in which he groups the clichés together; for instance, the first grouping would contain as many as sixteen square degrees, but the second, third, &c., would cover just twice this number. With regard to "le problème du rattachement" he says, "Malgré tous les soins pris pour exécuter les photographies dans des conditions toujours semblables, il est impossible que les coordonnées mesurées sur deux clichés voisins soient immediatement et rigoureusement comparable. Chacun d'eux, en effet, représente la projection d'une portion de la sphère céleste sur un plan déterminé, et les plans de projection relatifs à deux plaques voisines sont inclinés l'un sur l'autre d'un certain angle. Les poses ont pu être effectuées à des époques très différentes; on ne saurait donc s'attendre à ce que la situation des plaques par rapport à l'axe de la lunette, l'orientation l'échelle des mesures soient identiques dans les deux cas. Par suite il est nécessaire de faire subir aux grandeurs mesurées certaines corrections, si l'on veut qu'elles constituent un système unique et homogène de coordonnées." In his first memoir M. Lœwy has already given the formulæ, &c., for reduction, and in the one to which we refer below he gives us an application of his method.

In *Comptes Rendus* for April 4 (No. 14) M. Lœwy states the results that he has obtained in applying his method of determining the coordinates of the stars on the clichés for the Photographic Chart. As it would be impossible to give an idea of this computation without entering into the subject at some length, it seems best that we should leave it quite alone and refer our readers to the journal itself, from which he will get full information. Suffice it for us to say that in the different methods of "raccordement" based on twenty-six well determined positions, the probable error of the equatorial coordinates amounts nearly to $\pm 0''\!\cdot\!1$, but "comme il faut encore admettre les erreurs réelles plus fortes qui les valeurs théoriques calculées, il devient evident que le degré d'exactitude obtenu, bien que suffisant, est loin d'être exagéré."

CATALOGUE OF SOUTHERN STAR MAGNITUDES.—In vol. xii. no. 1 of the *Memoirs of the American Academy of Arts and Sciences* will be found the results in catalogue form of Mr. Edwin Sawyer's determinations of the magnitudes of southern stars from 0° to −30° Declination to the 7th magnitude inclusive.

The general plan was to observe every star three times, and out of the total number of stars in the catalogue (3415) 289 stars were observed less than this number of times, while 1048, 491, and 194 stars were observed four, five, and six times respectively, and the rest seven times or more. The various differences of brightness were estimated by Argelander's method of step-estimations, each sequence comprising ten, five, or twenty stars according to the number of stars in the vicinity observed. Commencing in the year 1882, Mr. Sawyer says that nearly half of the whole work was done in that time, an opera glass being extensively used for fainter sequences, such as those in which the stars were of the 6th or fainter magnitude a field glass was employed. During the years 1883 and 1885 the observations, as he tells us, were wholly discontinued, "owing to the injury to the eyes from the trying nature of the work." In the method of reduction the magnitudes were deduced by plotting out the sequences, graphically using the *Uranometria Argentina* magnitudes as ordinates, and the observed differences of brightness, expressed in steps, as abscissas. The arrangement of the catalogue itself is as follows:—The columns give successively the catalogue current number of the star, U. A. catalogue number, constellation, Right Ascensions and Declinations for mean equinox 1875.0, number of observations, mean magnitude deduced, U.A. magnitude, and the three last the separate dates of the observations and magnitudes.

Comparing the average differences between the magnitudes here assigned and those given by Gould, it is found that ± 0·088m. about represents it, while the average error of a single determination, assuring equal degree of precision and including besides accidental errors, the effect of systematic difference is given as ± 0·059m.

While the work was in hand eight variables were discovered, which were as follows:—U Ophiuchi (1881), U Ceti (1885), U Aquilæ and Y Sagittarii (1886), R Canis Majoris (1887), Y Ophiuchi and W Hydræ (1888), and (?) Leporis (1891), and in addition several large discordances were noticed in many values obtained (the catalogue number of these are here given), rendering these stars worthy of special attention. The volume concludes with notes, in which several suspicious cases of variables, &c., are recorded.

A NEW TABLE OF STANDARD WAVE-LENGTHS.—Under this title Prof. H. A. Rowland contributes to *Astronomy and Astrophysics* for April (No. 114) the new measurements of several metallic lines to be used as standards. The actual measures were made by Mr. L. E. Jewell, the probable error of one setting amounting to 1 part of 5,000,000 of the wave-length, and the reductions of the reading by Prof. Rowland himself. The measurements were obtained with a new machine, supplied with a screw specially made after Prof. Rowland's process. The standard wave-length of D used was the mean of the determinations of Angström, Müller and Kempf, Kurlbaum, Pierce, and Bell, and was 5896·156, different weights being given to these separate values. This value was utilised in six different ways, and the resulting table of wave-lengths from 2100 to 7700 was obtained, the accuracy of which might, as he says, be estimated as follows:—"Distribute less than $\frac{1}{100}$ division of Angström properly throughout the table as a correction, and it will be perfect within the limits 2400 and 7000."

METEOR SHOWERS.—Among the principal meteor showers for the current year, a list of which is given in the *Companion to the Observatory*, the following two occur this week, the former of which is described by Denning as "one of the most briliant showers." The radiant points are:—

Date	Radiant α	δ	Meteors
April 20 ...	270°	+ 33° ...	Swift
,, 25 ...	272°	+ 21° ...	Swift; short

WOLSINGHAM OBSERVATORY, CIRCULAR NO. 35.—A plate taken with the Compton 8-inch photo-telescope, April 11, compared with a photo by Max Wolf, 1891, shows that the two stars

Es-Birm 545 18h. 28·9m. + 36° 55′ (1900)
,, 561 18h. 39·4m. 36° 52′ ,,

are var., the photo differences being approximately 9·1, 11·4; 8·8, 10·2.

GEOGRAPHICAL NOTES.

LETTERS dated March 9 have been received from the Antarctic whaling vessels confirming and extending the brief telegraphic information already published. The ships did not proceed farther south than 67° latitude, and discovered no signs of the existence of the Greenland whale, although whales of several other species were common, and there were great numbers of grampuses. In default of whaling, the energy of the crews was devoted to sealing, and the four vessels secured between them about 16,000 skins and a full cargo of oil. The seals were of several varieties, but until the return of the ships their species cannot be determined, nor their commercial value known. The weather throughout the whole stay in Antarctic waters was severe, and the formation of ice compelled the vessels to return at an earlier date than was at first intended. Flat icebergs of enormous size were seen, one being reported as fifty miles in length. The facilities afforded for scientific work were disappointing.

THE Delcommune expedition (p. 474) has returned to Europe, and M. Delcommune was received with great enthusiasm in Brussels. The expedition, together with the others sent out by the Katanga Company, has to a large extent completed the work of Livingstone and his successors in the Congo Basin, and in the main confirms the accepted geography of the region. One point of some interest which has been established is that the Lake Lanji, marked from Arab reports at the junction of the Lukuga and the Lualaba, has no existence.

THE new number of *Petermann's Mitteilungen* contains a short paper by Prof. Krümmel on recent Russian oceanographical work in the north Pacific. This is accompanied by a map of the salinity of the surface water, which extends, and in a general way confirms, Mr. Buchanan's map founded on the *Challenger* work. The centre of maximum salinity lies between 20° and 30° N., and has its centre about 170° W. A tongue of considerably fresher water stretches nearly across the ocean, about 10° N. and sweeps round the coasts of America and Asia. The diminution of salinity northward is very interesting, the curves of equal salinity sweeping through Bering Sea without regard to the line of Aleutian Islands, thus showing that so far as regards surface water, Bering Sea is simply part of the Pacific ocean, standing in very marked contrast to the Sea of Okhotsk, a fact of some interest during the present international controversy.

MR. T. H. HATTON-RICHARDS read a paper on British New Guinea at the last meeting of the Royal Colonial Institute. While giving an account of the climate discouraging to would-be white settlers, Mr. Richards describes the native Papuans from personal experience as a fine race, possessing a keen sense of justice, and most laborious and successful as agriculturists.

RECENT INNOVATIONS IN VECTOR THEORY.[1]

OF late years there has arisen a clique of vector analysts who refuse to admit the quaternion to the glorious company of vectors. Their high priest is Prof. Willard Gibbs. His reasons for developing a vector analysis devoid of the quaternion are given with tolerable fullness in NATURE, vol. xliii. p. 511. His own vector analysis is presented in a pamphlet, "Elements of Vector Analysis, arranged for the Use of Students in Physics, not Published" (1881–84). Mr. Oliver Heaviside, in a series of papers published recently in the *Electrician* and in an elaborate memoir in the *Philosophical Transactions*, supports some of Gibbs's contentions and cannot say hard enough things about the quaternion as a quantity which no physicist wants. Prof. Macfarlane, of Texas University, has added to the literature of the subject, and without altogether agreeing with Gibbs takes umbrage at a most fundamental principle of quaternions and developes a pseudo-quaternionic system of vector algebra which is non-associative in its products!

Between the years 1846–52, just at the time when Hamilton was developing the quaternion calculus, a series of papers was published by the Rev. M. O'Brien, Professor in King's College, London. The system developed by O'Brien is essentially that

[1] Abstract of a paper by Prof. C. G. Knott, read before the Royal Society of Edinburgh, on Monday, December 19, 1892.

advocated by Gibbs and Heaviside. Two products of vectors are defined, which correspond to Hamilton's $V\alpha\beta$ and $-S\alpha\beta$; and applications are given of the linear and vector function and of the operator $\alpha\partial_1 + \beta\partial_2 + \gamma\partial_3$ which somewhat resembles the quaternion ∇.

The broad argument advanced by Gibbs in his letter to Nature is that, in comparison with the quantities $V\alpha\beta$ and $S\gamma V\alpha\beta$, which symbolise an area and a volume which "are the very foundations of geometry," anything that can be urged in favour of the quaternion product or quotient as a "*fundamental* notion in vector analysis" is "trivial or artificial." These are brave words. Let us examine them by considering what is the purpose of a vector analysis. Clearly such a calculus is intended to show forth the properties of vectors in a form suitable for use.

Having formed the conception of a vector, we have next to find what relations exist between any two vectors. We have to compare one with another, and this we may do by taking either their difference or their ratio. The geometry of displacements and velocities suggests the well-known addition theorem—

$$\alpha + \delta = \beta$$

in which by adding the vector δ we pass from the vector α to the vector β.

But this method is not more fundamental geometrically than the other method which gives us the quaternion. When we wish to compare two lengths a and b, we divide the one by the other. We form the quotient a/b, and this quotient is defined as the factor which changes b into a. Now a vector is a directed length. By an obvious generalisation, therefore, we compare two vectors by taking their quotient and by defining this quotient α/β as the factor which changes the vector β into the vector α. This is the germ out of which the whole of vector analysis naturally grows. A more fundamental conception it is hardly possible to make. Yet Gibbs calls it trivial and artificial! Far more fundamental, we are told, are the conceptions of a vector bounded area and a vector bounded volume, whose bounding vectors may have an infinity of values. Or take the more general case of a body strained homogeneously. The relative vector of any two of its points passes into its new position by a process which is a combination of stretching and turning. A simpler and more complete description cannot be imagined. It is perfectly symbolised by the quaternion with its tensor and versor factors. And *this* is trivial and artificial—as trivial, say, as the versor operation which every one performs when estimating the time that must be allowed to catch a train. . . .

Another argument advanced by Willard Gibbs is in the paragraph beginning: "How much more deeply rooted in the nature of things are the functions $S\alpha\beta$ and $V\alpha\beta$ than any which depend on the definition of a quaternion, will appear in a strong light if we try to extend our formulæ to space of four or more dimensions." To elucidate the "nature of things" by an appeal to the fourth dimension—to solve the Irish question by a discussion of social life in Mars—it is a grand conception, worthy of the scorner of the trivial and artificial quaternion of three dimensions. Further on we are told that there "must be vectors in such a space"; that is, space of four or more dimensions. True, and if there be vectors, must there not be operations for changing one vector into another? . . . .

"Vectors must be treated vectorially" is a high-sounding phrase uttered by Prof. Henrici and Mr. Heaviside. What does it mean? On the same sapient principle, I suppose, scalars must be treated scalarially, rotors rotorially, algebra algebraically, geometry geometrically. That is to say the remark is a very loose statement of a truism, or it is profound nonsense. Strictly speaking, to treat vectorially is to treat after the manner of vectors, or to treat *as vectors do*.

Now what does a vector do? Prof. Gibbs, the prince of vector purists, says on page 6 of his pamphlet that "the effect of the skew [or vector] multiplication by α [any unit vector] upon vectors in a plane perpendicular to α is simply to rotate them all 90° in that plane." Hence a vector *is* a versor. To which Mr. Heaviside in fierce denunciation: "In a given equation [in quaternion-vector analysis] one vector may be a vector and another a quaternion. Or the same vector in one and the same equation may be a vector in one place and a quaternion (versor or turner) in another. This amalgamation of the vectorial and quaternionic functions is very puzzling. You never know how things may turn out." Puzzling? Then must Heaviside find his own system as puzzling as any. For when he writes the vector product $ij = k$, he is simply acting on j by i or on i by j, and turning it through a right angle. It is impossible to get rid of this versorial effect of a vector. It stares you in the face from the very beginning.

A very sore grievance with Heaviside and Macfarlane—although Gibbs cautiously steers clear of the whole question—is that Hamilton puts i^2, j^2, k^2, each equal to negative unity, with the consequence that $S\alpha\beta$ is equal to $-ab\cos\theta$, where a and b are the lengths of α and β, and θ the angle between them. This putting the square of a vector equal to *minus* the square of its length vexes their souls mightily. It is so "unnatural," so troublesome.

Now Prof. Kelland, in Kelland and Tait's "Introduction to Quaternions," chap. iii., shows that if we assume, as do Heaviside and Macfarlane, the cyclic relations

$$ij = k = -ji \quad jk = i = -kj \quad ki = j = -ik,$$

and if in addition we desire an *associative* algebra, then *of necessity* we must have $i^2 = j^2 = k^2 = -1$. If then, following these O'Brienites, we put what they consider to be so much simpler and more natural, namely, $i^2 = j^2 = k^2 = +1$, we get a non-associative algebra of appalling complexity, which in the long run gives us no more than the associative quaternion algebra.

Heaviside apparently is unaware of the non-associative beauties of his system, which he believes "to represent what the physicist wants;" for he says, much to the credit of the *Philosophical Transactions*, that his system (which is demonstrably *not* quaternions) is "simply the elements of quaternions without the quaternions, with the notation simplified to the uttermost, and with the very inconvenient *minus* sign before scalar products done away with" (*Phil. Trans.*, vol. clxxxiii. 1892, p. 428).

We have seen how perfectly natural is the geometric conception of a quaternion as the quotient of two vectors; and the quaternion product is as simply conceived of as the operator $(\alpha\beta)$ which turns the vector β^{-1} into α. Space considerations quickly lead us to consider quaternions which rotate a given vector through a right angle. If we take two such right or quadrantal quaternions I I′ and operate severally on the vector α that is perpendicular to the axes of both, it is easy to show that

$$\mathrm{I}\alpha + \mathrm{I}'\alpha = (\mathrm{I} + \mathrm{I}')\,\alpha$$

gives a right quaternion $(\mathrm{I} + \mathrm{I}')$ bearing to I and I′ the same relation which would exist were I and I′ vectors. That is, right or quadrantal quaternions are added and subtracted according to the recognised rules for vector addition and subtraction, which so far, be it noted, are all we know about vectors. Hence in combinations other than addition and subtraction we may treat vectors as quadrantal quaternions, exactly as Gibbs, Heaviside, and Macfarlane do, although in a half-hearted fashion.

It remains now to consider wherein the systems advocated by these vector analysts improve upon Hamilton's. Do they give us anything of value not contained in quaternions?

Prof. Gibbs, having objected *in toto* to the quaternion product $\alpha\beta$, is for consistency's sake bound to object to Hamilton's selective principle of notation. His own notation is very similar in appearance to O'Brien's of old. He defines two products, the *direct* product $(\alpha . \beta)$ and the *skew* product $(\alpha \times \beta)$. The direct product is Grassmann's inner product or Hamilton's $-S\alpha\beta$; and the skew product is $V\alpha\beta$, so called probably because it has a value only when α and β are skew, or inclined to one another. Now there is a serious objection at the very outset to such a form as $\alpha \times \beta$ for the vector product of α and β. There corresponds to it no quotient amenable to symbolic treatment. The reason is, of course, that $\alpha \times \beta$ is not a complete product. Given the quaternion equation $\alpha\beta = q$, any one quantity is uniquely determined if the other two are given. But it is impossible, in spite of the suggestiveness of the form, to throw Prof. Gibbs's $\alpha \times \beta = \gamma$ into any such shape as $\alpha = \gamma \div \beta$. The point is that Hamilton's notation does not even suggest the possibility of such a transformation. It is certainly inexpedient, to say the least, to use a notation strongly resembling that for multiplication of ordinary algebraic quantities, but having no corresponding process by which either factor can be carried over as a generalised divisor to the other side of the equation.

One peculiar perspicuity of Hamilton's notation arises from the fact that S and V are thrown out in bold relief from amongst the small Greek letters used for vectors and the small

Roman letters used for quaternions and scalars. A glance tells us what kind of quantity we have to deal with before we are called upon to inquire into its composition. There is no such eye-catching virtue in Gibbs's notation; and Heaviside largely destroys the contrast between the quantities and selective symbols by using capital letters for all. In print the vectors are made heavy and stand out prominently enough. But a vector analysis is a thing *to be used;* and with pencil or pen or chalk on a blackboard it is hopeless to prevent confusion between A and **A**. In suggesting a suffix notation for manuscript, Heaviside unconsciously condemns his own system. Two conditions for a good notation are (1) an *unmistakeable* difference between *easily written* symbols for scalar and vector quantities; (2) the scalar and vector parts of products and quotients thrown out in clear relief. This second is quite as important as the first condition. So far, Hamilton's notation easily holds its own.

A very important symbol of operation is the Nabla, ∇, which may be defined in the form $\alpha\partial_1+\beta\partial_2+\gamma\partial_3$ where $\partial_1\partial_2\partial_3$ are space-differentiations along the mutually rectangular directions of the unit vectors $\alpha\beta\gamma$. Since Heaviside and Macfarlane make $\alpha^2\beta^2\gamma^2$ each equal to $+1$, they find that $\nabla^2 u$, where u is any scalar, is $d^2u/dx^2 + d^2u/dy^2 + d^2u/dz^2$. The real $\nabla^2 u$ is *minus* this quantity. When ∇^2 acts on a vector, Heaviside boldly defines $\nabla^2\omega$ as having the same significance; but Macfarlane, rejoicing in his non associative algebra, finds that $\nabla(\nabla\omega)$ is quite a different quantity from $(\nabla\nabla)\omega$. The net result attained by this tinkering of the signs is to get a pseudo-nabla non-associative with itself!

Gibbs moves more cannily. He defines separately the quantities ∇u, $\nabla\times\omega$, $\nabla.\omega$, and $\nabla.\nabla\omega$, which mean the same things as the quaternion quantities ∇u, $V\nabla\omega$, $-S\nabla\omega$, and $-\nabla^2\omega$. [In quaternions there is one definition of ∇, and everything else follows.] But even with these four definitions (all of which are properties somewhat distorted of the real Nabla) Gibbs finds his system lacking in flexibility. He has, so to speak, to lubricate its joints by pouring in the definitions of four other functions with as many new symbols. One of these is the Potential; the others are called the Newtonian, Laplacian, and Maxwellian. They are symbolised thus—Pot, New, Lap, Max. Their meanings will be evident when they are exhibited in quaternion form. Thus, as is well known,

$$\left(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}+\frac{\partial^2}{\partial z^2}\right)\text{Pot } u = -4\pi u,$$

from which at once

$$\nabla^2 \text{ Pot } u = +4\pi u$$

or

$$\text{Pot } u = 4\pi\nabla^{-2}u.$$

Similarly, if ω is a vector quantity,

$$\text{Pot } \omega = 4\pi\nabla^{-2}\omega.$$

Then we have

$$\text{New } u = \nabla \text{ Pot } u = 4\pi\nabla^{-1}u$$

$$\text{Lap } \omega = V\nabla \text{ Pot } \omega = 4\pi V\nabla^{-1}\omega$$

$$-\text{ Max } \omega = S\nabla \text{ Pot } \omega = 4\pi S\nabla^{-1}\omega.$$

Now, Prof. Gibbs gives a good many equations connecting these functions and their various derivatives, equations which in quaternions are *identities* involving the *very simplest* transformations. But there is no such simplicity and flexibility in Gibbs's analysis. For example, he takes eight distinct steps to prove two equations, which are special cases of

$$\nabla^{-2}\nabla^2 u = u\,!$$

Another of his *theorems*, namely,

$$4\pi \text{ Pot } \omega = \text{Lap Lap } \omega - \text{New Max } \omega$$

is simply the quaternion *identity*

$$4\pi\nabla^{-2}\omega = 4\pi\nabla^{-1}\nabla^{-1}\omega$$

$$= 4\pi\nabla^{-1}V\nabla^{-1}\omega + 4\pi\nabla^{-1}S\nabla^{-1}\omega.$$

Similarly the equation

$$4\pi \text{ Pot } u = -\text{ Max New } u$$

is a travesty of

$$4\pi\nabla^{-2}u = 4\pi\nabla^{-1}\nabla^{-1}u!$$

These extremely simple quaternion transformations cannot be obtained with the operator used by Gibbs. Hence the necessity he is under to introduce his Pot, New, Lap, Max, which are merely inverse quaternion operators. . . .

Gibbs's system of dyadics, which Heaviside regards with such high admiration, differs from Hamilton's treatment of the linear and vector function simply by virtue of its notation. In his letter to NATURE he gives reasons why this notation is preferable to the recognised quaternion notation. As developed in the pamphlet, the theory of the dyadic goes over much the same ground as is traversed in the last chapter of Kelland and Tait's "Introduction to Quaternions." With the exception of a few of those lexicon products, for which Prof. Gibbs has such an affection,[1] there is nothing of real value added to our knowledge of the linear and vector function. As usual, the path is littered with definition after definition. Thus the *direct product*[2] of two dyads (indicated by a dot) is defined by the equation $\{\alpha\beta\}.\{\gamma\delta\} = \beta.\gamma\alpha\delta$. Quaternions gives at once

$$\phi\psi\rho = \alpha S\beta(\gamma S\delta\rho) + \&c. = \alpha S\delta\rho S\beta\gamma + \&c.$$

Then there follow the definitions of the *skew* products of ϕ and ρ, thus—

$$\phi\times\rho = \alpha\lambda\times\rho + \beta\mu\times\rho + \gamma\nu\times\rho$$

$$\rho\times\phi = \rho\times\alpha\lambda + \rho\times\beta\mu + \rho\times\gamma\nu.$$

These are not quantities but operators. To see what they mean let them operate on some vector σ. Then we find

$$\phi\times\rho\,.\,\sigma = \alpha S\lambda\rho\sigma + \ldots = \phi V\rho\sigma$$

$$\rho\times\phi\,.\,\sigma = V\rho\alpha S\lambda\sigma + \ldots = V\rho\phi\sigma.$$

The first is simply $\phi\varpi$, the old thing! The second is a well-known and important quantity in the theory of the linear and vector function. It is interesting to note, as bearing upon the *intelligibility* of the notation, that Heaviside, who dotes so on the dyadic, writes $\phi\times\rho$ in the form $V\phi\rho$, so that he makes

$$\phi V\rho\sigma = -V\sigma\phi\rho\,!\,!$$

As one example of our *gain* in following Gibbs's notation, take his dyadic identity—

$$\psi\,.\,\{\rho\times\phi\} = \{\psi\times\rho\}\,.\,\phi,$$

on which the comment is that "the braces cannot be omitted without ambiguity." The quaternion expression is $\psi V\rho\phi\sigma$, where there is no chance of ambiguity, where everything is perfectly straightforward, and where there is much greater compactness in form. It seems to me that this last equation given by Gibbs condemns his whole principle of notation. It shows that one use of connecting symbols is to obscure the significance of a transformation. . . .

A beautiful example of virtually giving back with the left hand what he has taken away with the right is furnished on p. 42 of Gibbs's pamphlet. He writes: "On this account we may regard the dyad as the most general form of product of two vectors. We shall call it the indeterminate product." And then he shows how to obtain a vector and a scalar "from a dyadic by insertion of the sign of skew or direct multiplication."

This is exquisite. From the *operator* $\alpha\lambda+\beta\mu+\gamma\nu$, he forms —heedless of his high toned scorn for the quaternion product—the conception of the sum of three similar though more general products, but quiets his conscience by calling them *indeterminate!* This sum of products then becomes by simple insertion of dots and crosses the vector

$$\phi_\times = \alpha\times\lambda + \beta\times\mu + \gamma\times\nu,$$

and the scalar

$$\phi_s = \alpha\,.\,\lambda + \beta\,.\,\mu + \gamma\,.\,\nu.$$

Why, we naturally ask, is this *indeterminate* product welcomed where the *quaternion* product is spurned?

The truth is the quaternion, or something like it, has to come in; and in it most assuredly does come when Gibbs proceeds to treat the versor in dyadic form. The expression $\{2\beta\beta - I\}\,.\,\{2\alpha\alpha - I\}$ represents in Gibbs's notation the quaternion operator

$$\beta\alpha(\quad)\alpha\beta, \text{ or more simply } q(\quad)q^{-1}.$$

The I is called an *idemfactor* and is simply unity. . . .

There is something almost naïve in the way in which Heaviside introduces the dyadic as if nothing like it was to be found

[1] We are surprised that so much etymological erudition should accept such a monstrosity as parallelOpiped.

[2] Gibbs calls the quantity $\phi.\sigma$ (which is simply Hamilton's $\phi\sigma$) the direct product of the dyadic ϕ and the vector σ. The direct product of two vectors is $\alpha.\beta$, and this Heaviside calls the scalar product. Similarly translating the Gibbsian dialect, he speaks of $\phi\sigma$ as being the "scalar product of the dyadic and the vector"—and gets a scalar product equal to a vector! This "is most tolerable and not to be endured."

in either Hamilton or Tait. The truth is it is all there. Hamilton showed long ago that if

$$\phi\rho = \alpha S\lambda\rho + \beta S\mu\rho + \gamma S\nu\rho,$$

then

$$\phi^{-1}\rho = \lambda_1 S\alpha_1\rho + \mu_1 S\beta_1\rho + \nu_1 S\gamma_1\rho,$$

where

$$\alpha_1 S\alpha\beta\gamma = V\beta\gamma, \text{ \&c.}, \ \lambda_1 S\lambda\mu\nu = V\mu\nu, \text{ \&c.}$$

Now Heaviside fusses greatly over this method of inverting ϕ, and any reader of § 172 ("Electromagnetic Theory," in the *Electrician*), would infer that the invention of the name dyadic suggestion this demonstration which Hamilton and Tait had somehow missed in their development of "the very clumsy way" of expressing $\phi^{-1}\rho$ in terms of ρ, $\phi\rho$, and $\phi^2\rho$. But the whole thing is given in Hamilton's "Elements" (p. 438, equation xxvii.), and in Tait's "Quaternions" (p. 89, second edition; p. 123, third edition). I would also refer to § 174 of Tait's third edition (§ 162 of the second), a comparison of which with Heaviside's tall talk in the *Electrician* of November 18, 1892 (§ 171), will show that, on the most lenient hypothesis available, our self-appointed critic of Tait's methods has never really read Tait's "Quaternions." . . .

All through his system Prof. Gibbs has refused to consider the complete product of two vectors. He has used the form $\alpha\beta$ to mean a "dyad" or operator of the form $\alpha S\beta$ or $\beta S\alpha$. What, then, can he mean us to understand by the equations—

$$\iint d\sigma\omega = \iiint dv\nabla\omega \quad ((2) \text{ of § } 164),$$

and

$$\int d\rho\omega = \iint d\sigma \times \nabla\omega \quad ((2) \text{ of § } 165).$$

In quaternion notation the last would be written

$$\int d\rho\omega = \iint V(d\sigma\nabla)\omega.$$

Both equations are quite correct if and only if $d\sigma\omega$, $d\rho\omega$, and $\nabla\omega$ are taken in their quaternion meaning of *quantities*. But Gibbs has wilfully cut himself adrift from this interpretation. How, then, does he interpret these equations?

The chief arguments of the paper may be briefly summarised thus:—

(1) It is maintained that the quaternion is as fundamental a geometrical conception as any that Prof. Gibbs has named.

(2) In every vector analysis so far developed, the versorial character of vectors in product combinations is implied if not explicitly stated.

(3) This being so, it follows as a *natural* consequence that the square of a unit vector is equal to negative unity.

(4) The *assumption* that the square of a unit vector is positive unity leads to an algebra whose characteristic quantities are non-associative, and whose ∇ is not the real efficient *Nabla* of quaternions.

(5) The invention of new names and new notations has added practically nothing of importance to what we have already learned from quaternions.

EXPERIMENTAL MEDICINE.[1]

THIS volume is the fourth number of this remarkable publication, and will prove of surpassing interest to the bacteriologist, physiologist, and physician, chiefly on account of the first paper which it contains.[2]

In 1877 Dr. N. V. Eck invented an operation by which it was possible to alter the circulation in such a manner that the blood flowed from the portal vein into the inferior vena cava without passing through the liver. He succeeded in establishing an artificial opening between these veins in several dogs, and then tied the portal vein near the liver; unfortunately, only one dog lived for any length of time (two and a half months), and, owing to an accident, Dr. Eck was unable to control the result by post-mortem examination. The operation has now been repeated at the St. Petersburg Institute, and it has been found that in successful cases the blood passed entirely from the portal vein into the inferior vena cava.

The animals which successfully resisted this severe operation showed no alteration in the appetite, though after a period of ten days or so their temper underwent marked changes. Although perfectly docile before the operation, they now became bad-tempered, bit everything that came in their way, and showed undue excitement on trifling provocation. The animals became weak, and their gait ataxic, whilst the sensory apparatus was also greatly disturbed, as they often became blind, and appeared to lose all sensation of pain. In a further stage convulsions and coma supervened; though the animals occasionally recovered perfectly after a time, many of them died when the first attack of excitement and convulsions occurred, or succumbed to subsequent attacks, although, on the whole, the latter rarely proved fatal. The temperature showed no changes attributable to the veinous fistula, but the weight generally diminished until death supervened, although, in animals which recovered it reached, or even exceeded, the original weight. The appetite was good, though capricious; but a distinct relation was found to exist between the state of the alimentary canal and the attacks of excitement before mentioned. The animals which absolutely refused to eat meat remained free from the attacks, while the "crises" invariably occurred in the dogs that ate meat voraciously. It is a remarkable fact that many of them learnt by experience that meat was bad for them, and declined to take it.

Some dogs recovered perfectly, and at the postmortem it was found that a collateral circulation had been set up, so that the portal blood again circulated through the liver.

It would appear from further observations that these symptoms are due to the toxic action of the products of the transformation of nitrogenous food, the liver being unable to convert them into urea and uric acid. Carbamic acid was found in the urine of these animals, and carbamate of sodium or calcium, when introduced into a healthy animal's stomach, produced exactly the same symptoms as the fistula above described. On the other hand, it was found impossible to poison healthy dogs with the same salt, provided the setting free of carbamic acid was prevented by the simultaneous introduction of carbonate of soda into the stomach, while the introduction of both salts gave rise to all the symptoms of carbamic acid poisoning, when the circulation through the liver had been interrupted. The authors conclude, therefore, that the carbamates formed during digestion in passing through the liver are transformed into a harmless substance, and that this substance is most probably urea.

In some cases the experimenters removed the entire liver; but the animals never lived more than six hours, and fell at once into a comatose state, followed by convulsions, tetanus, and death through arrest of the respiration. Similar results were obtained by establishing a veinous fistula in the first place and tying the hepatic artery afterwards.

According to Messrs. Hahn and Nencki, who performed the chemical part of these observations, the reaction of the urine remained normal until one of the attacks of excitement set in, when it became alkaline. If the hepatic artery were tied at the same time, the urine contained a little albumin and hæmaglobin, together with small quantities of urobilin and biliary pigment, provided the gall-bladder had not been emptied before the operation. The quantity of urea was always greatly lessened if the hepatic artery were also tied, or the greater part of the liver removed. The relation of the nitrogen in urea to the total quantity of nitrogen excreted was much smaller than normal, being only 77 per cent. instead of 89 per cent. On the other hand, the uric acid in the urine ultimately increased in quantity, even when the hepatic artery was not tied, although the total quantity of nitrogen excreted was not greater than normal, the increase in the uric acid corresponding to the setting in of the convulsions. With regard to the ammonia contained in urine, the authors have come to the following conclusions:—(1) Eck's operation, combined with the ligature of the hepatic artery, causes in dogs an increase in the excretion of ammonia. In some cases this increase is relative only with regard to the nitrogen of urea or the total nitrogen, whereas in other cases it is absolute, and this absolute increase takes place when the animals survive the operation for twenty hours at least; (2) the secretion of ammonia increases rapidly in animals which have been subjected to Eck's operation as soon as the first symptoms set in.

In a further series of researches the authors showed that car-

[1] "Archives des Sciences biologiques publiés par l'institut impérial de médecine experimentale à St. Pétersbourg," vol. i. no. 4.

[2] "La fistule d'Eck de la veine cave inférieure et de la veine porte, et ses conséquences pour l'organisme, par MM. les Drs. M. Hahn, V. Massen, M. Nencki, et J. Pawlow."

bamic acid is present in the urine of a normal animal, and increases after Eck's operation. It would be interesting therefore to compare these facts with what we know of the increase of ammonia in pathological states of the liver in man. The liver, however, is not the only place where urea is formed, for the urea never completely disappeared in any of these experiments; and it is well known that in sharks which live seventy hours after the removal of the liver, the urea in the muscles does not diminish after the operation.

Such are the chief new facts we have met with in this interesting memoir, and it is certain that these investigations open up a new field for further researches. The other papers [1] contained in this volume call for little comment; they relate chiefly to the digestive and putrefactive processes taking place in the human intestinal tract.

It will be seen, however, that this fourth number sustains the well-earned reputation of the three first ones, and that the archives deserve to take their place among the chief scientific journals which made their first appearance in the year 1892.

[1] "On the Putrefactive Processes in the Large Intestine of Man and on the Microbes Causing Them," by M. Lumft. "On the Micro-organisms in the Organs of Choleraic Patients," by M. L. de Rekowski. "Contributions to the Study of Chemical Processes in the Intestines of Man," by M. Jakowski.

STEAM ENGINE TRIALS.

A PAPER on the last series of steam-engine trials undertaken by the late Mr. P. W. Willans was read at the meeting of the Institution of Civil Engineers on April 11.

The paper dealt with an extensive series of condensing trials made with a 40 I.H.P. Willans Central-Valve Engine. These were intended to form a sequel to the investigations described in the author's papers, entitled "Economy Trials of a Non-condensing Steam Engine, Simple, Compound, and Triple," read before the Institution in 1888 and 1889. The principal objects in undertaking these trials were—(1) To ascertain the initial condensation in the first cylinder, and to trace the behaviour of the steam in the succeeding cylinders, when working as a compound or triple-expansion engine; (2) To observe the effect of speed of rotation, area of exposed surface, and range of temperature, upon the initial condensation, and upon economy generally; (3) To ascertain the percentage of the theoretical mean pressure actually obtained; (4) To ascertain the ratio of the work done by each pound of steam to the theoretical work due from it; (5) To determine the consumption of steam at all loads, and under various conditions.

The consumption of steam was determined by discharging the condensed water from the exhaust into a tank carried by a weighbridge, and observing the intervals of time required for fixed weights of water to run in. By this method, a continual watch was kept on the performance of the engine during the whole trial, and any disturbing cause was immediately detected; leaky steam-pipe joints did not affect the result, and the length of the trial might be much reduced. Special experiments, made to ascertain whether any addition was necessary to cover leakage in the engine and exhaust-pipe, showed that this leakage was slight.

The method of determining the theoretical work due from one pound of saturated steam when discharging into a condenser was next considered, and it was shown that the thermal efficiency of a condensing engine must of necessity be less than that of a non-condensing engine, owing to the greater proportionate size of the "toe" of the diagram cut off for practical reasons. In the non-condensing trials the best number of expansions was computed from the approximate formula $p^6 v^7$ = constant; but for the condensing trials the error in this could not be neglected. The best ratio of expansion and mean pressure were therefore calculated for adiabatic expansion, by Mr. Macfarlane Gray's $\theta\ \phi$ diagram, combined with a volume curve. Altogether sixty-two trials were made under various conditions of speed, steam-pressure, load, and ratio of expansion, as well as with the engine working simple, compound, and triple, and the results were embodied in the tables accompanying the paper.

One of the principal deductions from these experiments was the "straight-line" law of steam-consumption; and it was shown by diagrams that the *total* water for the horse-power corresponding to any mean pressure P, was W + K P., where W was the water which would be used by the engine at zero mean pressure (through initial condensation, radiation and conduction), supposing it were frictionless, and K was the water per hour required to produce each pound of mean pressure. These factors were shown to vary with the conditions under which the engine was working.

Eighteen of the trials were planned to assist in determining the law connecting initial condensation with revolutions; and it was found that in the high-pressure cylinder at high mean pressures the total condensation per unit of time was directly proportional to the square root of the number of revolutions per unit of time. As the mean pressure was diminished, the condensation became more and more nearly constant at all speeds; and finally, at low mean pressures, the law appeared to be reversed. For the low-pressure cylinder, the law was modified.

The important question of the changing proportions of steam and water present during the expansive part of the stroke was investigated by the $\theta\ \phi$ diagram. The matter was first examined theoretically by considering the effect of a thin liner of infinitely conducting matter, and a curve was drawn on the $\theta\ \phi$ diagram showing the rate at which the steam initially condensed in warming up the liner from the exhaust to the initial temperature was re-evaporated as the expansion proceeded. The actual re-evaporation, as obtained by measurement of the indicator cards was compared with this theoretical re-evaporation, the difference measuring the delay in the return of the heat from the liner to the steam. The losses due to conduction and radiation, to passage through ports, and to incomplete expansion, could also be shown on the $\theta\ \phi$ diagram.

The question of the economical advantage of reducing the power by automatic cut-off *versus* throttling was discussed. Broadley, the result was that the gain by varying the expansion was large for a simple engine, moderate for a compound engine, and, for a triple engine, almost inappreciable. It further appeared that the gain at high speeds was greater than at low speeds.

A few trials made with the cylinders steam-jacketed showed a slight gain, but further experiments were required to show whether the gain was likely to be worth the extra trouble and expense involved.

The missing steam at cut-off varied in the trials to even a greater extent than it did in the non-condensing trials—the amount being much affected by the range of temperature, the density of the steam, and by other conditions.

It appeared that, under all circumstances, the triple-condensing engine showed an advantage over the compound in regard to steam-consumption; but that, except for very large engines, the compound-transfer engine was probably the best for pressures below 150 lbs. (absolute) pressure per square inch.

ETHNOLOGICAL OBSERVATIONS IN AUSTRALIA.

SOME time ago Mr. R. Etheridge, jun., carried on a series of geological and ethnological investigations in the valley of the Wollondilly River, at its junction with the Nattai River, New South Wales; and in the latest number of the "Records of the Australian Museum" (vol. ii. No. 4) he gives an interesting account of the various facts he had occasion to study. The following is the greater part of the passage in which he records his ethnological observations:—

The aborigines of the Wollondilly and Nattai Valleys, must, from local accounts, have existed in considerable numbers, and are now only represented by interments, carved trees, wizards' hands, and charcoal drawings in rock shelters along the precipitous escarpments.

The first objects investigated under this head were the "Hands-on-the-Rock." The "rock" consists of a huge mass of Hawkesbury Sandstone, about seventeen feet in breadth and length, hollowed out on the side overlooking the river to the extent of six feet. It is perched on the side of a gentle rise from the Wollondilly, having rolled from the higher ground above, and alongside the track from the Nattai Junction to Cox's River, in the immediate south-west corner of the Parish Werriberri. The cavernous front of the rock is fifteen feet

broad, and twelve feet high. On the back wall are depicted a number of red hands, both right and left. Under the principal hands are four white curved bands, resembling boomerangs or ribs, the whole of the hands being relieved, as is usually the case with these representations, by light splash-work. The hand-marks in this shelter differ, however, from any I have seen before by an unquestionably previous preparation of the rock surface for their reception by incising the surface to the shape of each hand, thus leaving a slightly raised margin around each. I have recently given (Records Geol. Survey, N.S. Wales, 1892, iii. Pt. i. p. 34) an epitome of our knowledge of these hand imprints, their method of preparation, and supposed significance sufficiently full to render any further reference unnecessary at present. The colour red, amongst black races, was the symbol of evil (Fraser, Journ. R. Soc., N.S. Wales for 1882 [1883], xvi. p. 213).

Mr. Maurice Hayes, of Queahgong, informed me that he has known the rock for the past fifty years, and that the imprints have not altered in the least. He found it difficult to obtain trustworthy information from the aborigines regarding them; they expressed ignorance, but ultimately gave him to understand that the "hands were the imprints of those of their Deity when on earth."

The large alluvial flats in this neighbourhood, along the Wollondilly, were, I was informed, great gathering grounds for the various tribes from many miles round, even those of Goulburn and Shoalhaven participating.

On a spur overlooking one of these green expanses, known as Gorman's Flat, immediately at the junction of the Wollondilly and Nattai Rivers, we investigated an interment, thirty years old, indicated by a single carved tree, but the device has, I regret to say, been wantonly destroyed. This grave is known to be that of "Jimmy Aremoy," or "Blackman's Billy," of the local tribe, and called in the aboriginal dialect *Ah-re-moy*, and was covered by a small mound at the foot of a small tree, forty-seven feet north of the carved tree, and had been surrounded by a sapling fence. After removing the mound and superincumbent soil, we found the grave had been filled with boulders and large pieces of rock to the depth of four feet six inches, whilst under this was a layer of split timber and bark. On removing this we found the skeleton well wrapt in what had once been an old coat, a blanket, and an opossum rug. The skeleton was doubled up in the usual manner, the arms drawn up to the breast, and the legs against the abdomen, placed on the right side, and facing the south-east. . . . Not the least interesting fact was the variety of articles placed with the deceased, according to aboriginal custom. Loose in the superincumbent earth we found an ingenious conversion of a piece of forked iron into a probable spear-head, a pointed stick, and some loose pieces of timber. Underneath the skeleton in various positions there occurred an old comb in two pieces, a thimble, a large iron spoon, the blade of another spoon, a small bullet mould, handle and portion of the tin-plate work of an old "quart-pot" or "billy-can," fragment of a clay tobacco pipe-stem, top of an old metal powder or shot case, containing shot and a few shirt buttons, and last, but by no means the least curious, a castor-oil bottle, still containing what seems to be a portion of the oil—this was placed directly under the head.

A little below the junction of the rivers we viewed the burial place of a "Chief" of the late local tribe, the interment having taken place about fifteen years ago. It lies contiguous to one of three marked trees placed in a triangle, the longest side or base of the latter being half a chain in length, and bearing north-west and south-east. The trees are still erect, although the carvings are more or less obliterated by bush fires, but they seem to have been chiefly in zig-zag lines, and of course cut with an iron tomahawk. The heavy rain prevailing at the time deterred us from investigating this burial.

This concluded our investigations in Burragorang proper, but on returning to Thirlmere, we diverted our course near Vanderville, across the Werriberri Creek to "The Hermitage," the estate of Mr. W. G. Hayes, parish of Burragorang, county of Camden. Through the kindness of Mr. Hayes we were allowed to examine a much more extensive burial ground than either of the preceding. Here, on a small plateau above and to the east of the Waterfall Creek, a branch of the Werriberri, and behind, or to the south of the homestead, are four graves of various sizes distinguished by four carved trees, more or less in a state of dilapidation. There does not appear to have been any geometrical form of arrangement assumed in the placing of these graves, unless it be a roughly rhomboidal one. We expected, from current report, to find five graves here, but four only rewarded our efforts. Three of the graves and three carved trees are more or less in a north-west and south-east line. Starting at the north-west corner, the figures on a She-oak (*Casuarina*) have been partially obliterated, ten feet from this is the first grave, and fourteen feet from the latter is another carved She-oak, now lying on the ground and much decayed. Fifty-one feet still further on occurs the largest grave, and at another fifty-one feet the third ornamented tree, a dead gum still standing but much burnt by bush fires, and bearing an extraordinary figure. Between the last grave and this tree, and deviating somewhat from the straight line in the third interment, at right-angles to the original starting point; and fifty-four feet from it at right angles, is the fourth carved tree, also a dead gum, bearing figures. At right angles to this again, and distant sixty-four feet, is the fourth grave, apparently without any indicating tree near it. We did not investigate the contents of these graves owing to want of time. . . .

I am not acquainted with any systematic account of Australian carved trees; in fact little seems to have been collectively written about them, and very few representations figured. Probably some of the earliest illustrations are those by Oxley, Sturt, and "W. R. G." presumed to be from the context of his writings, Mr. Surveyor W. R. Govett, of Govett's Leap fame. Oxley discovered a grave on the Lachlan, consisting of a semi-circular mound, with two trees overlooking it, barked and carved in a simple manner. (Journ. Two Expeds. Interior N.S. Wales, 1820, p. 139, plate). These carvings consisted of herring-bone on the one tree, and well-marked curved although simple lines on the other. The explorer Sturt noticed an oblong grave beyond Taylor's Rivulet, Macquarie River, around which the trees were "fancifully carved on the inner side," one with a figure of a heart (Two Expeds. Interior S. Austr., 1834, i., p. 14). The anonymous author (W. R. G.) describes an occurrence of this kind at Mount Wayo, County Argyle, in the following words:—"The trees all round the tomb were marked in various peculiar ways, some with zig-zags and stripes, and pieces of bark otherwise cut" (Saturday Mag. 1836, ix., No. 279, p. 184). A Mr. Macdonald states that the aborigines of the Page and Isis, tributaries of the Hunter River, carve serpentine lines on two trees to the north-west of each grave (Journ. Anthrop. Inst. Gt. Brit. and Ireland, 1878, vii., p. 256).

The figures are either composed of right lines or curves, more commonly the former, but a few instances have been recorded of natural objects, such as the outline of an Emu's foot, seen by Leichhardt on a gum tree in the Gulf Country (Journ. Overland Exped. Moreton Bay to Port Essington, 1847, p. 356). One thing is self-evident, such carvings possessed a dual if not a triple significance. We have already seen the employment of them to indicate an interment, presumably acting the part of a tombstone, for it is believed by some that the figures on a tree in each case correspond to those on the inner side of deceased's 'possum rug, the *mombarai*, or "drawing," which Fraser thinks was distinctive in each family, or a peculiar modification of the tribal *mombarai* (Journ. R. Soc. N.S. Wales for 1892 [1893], xvi., p. 201). So far as I can gather, such devices invariably indicated the last resting-place of a male. Mr. E. M. Curr states ("The Australian Race, 1886," ii., p. 433) that the Breeaba Tribe, at the head-waters of the Burdekin River, North Queensland, employed marked trees to commemorate a battle. He figures a tree from the banks of the Diamantina, barked and marked by a series of close, irregularly super-imposed notches, like those made by a black when climbing a tree. These, however, can hardly be compared to carvings.

According to Mr. J. Henderson, Dr. John Fraser, Mr. A. W. Howitt, and Mr. Macdonald previously mentioned, Bora Grounds are also embellished with carved trees. The first-named describes ("Obs. Colonies of N.S. Wales and V.D. Land," 1832, p. 145, pl. 3) the approach to one of these initiation places at Wellington as through "a long, straight avenue of trees, extending for about a mile, and these were carved on each side with various devices . . . At the lower extremity of this, a narrow pathway turned off towards the left, and soon terminated in a circle." Mr. Henderson further remarks that the fact of the use of this place for Bora purposes was communicated to him by the then headman of the tribe. Dr. Fraser says (Journ. R. Soc. N.S. Wales for 1882 [1883] xvi., p. 205) that the Gringai Tribe, one of the northern N.S. Welsh tribes, clear two circular enclosures, one within the other, for their Bora, and that the trees

growing around the smaller circle are carved "with curious emblematical devices and figures"; whilst Mr. Macdonald informs us that on the Bora ground of the Page and Isis River Natives, as many as a hundred and twenty marked trees occur round about (Journ. Anthrop. Inst. Gt. Brit. Ireland, 1878, vii., p. 256). Confirmation is further afforded by Mr. W. O. Hodgkinson, who saw a Bora ground on the Macleay River with "trees minutely tatooed, and carved to such a considerable altitude that he could not help feeling astonished at the labour bestowed on the work" (Smyth, "Aborigines of Victoria, 1878," i., p. 292).

If, as previously stated, according to current report, the designs on the trees be the same as those on the 'possum rugs, the transfer of them to the trees surrounding a grave must have had some important and lasting meaning to the survivors. The figures on the rug may have indicated some degree of ownership, a crest, coat of arms, or monogram, as it were, and in such a case the reproduction on the trees surrounding a grave may be looked upon as an identification of the deceased. Henderson speaks of the tree carvings as symbols. "A symbol is afterwards carved upon the nearest tree, which seems to indicate the particular tribe to which the individual may have belonged" ("Obs. Colonies of N.S. Wales and V.D. Land, 1832," p. 149). Or had they a deeper esoteric meaning, one only known to the learned men of the tribe? Smyth states ("Aborigines of Victoria, 1878," i., p. 288) that the figures on the inner sides of the 'possum rugs "were the same as those on their weapons, namely, the herring-bone, chevron, and saltier." How easily these same devices can be traced, in a general way, both on the carved trees and some of the wooden weapons, is amply shown by many of the excellent figures given in Smyth's work. This painstaking author, in briefly dealing—too briefly, in fact—with this interesting subject, says (*Ibid.* p. 286. The italics are mine): "The natives of the Murray and the Darling, and those in other parts adjacent, carved on the trees near the tombs of deceased warriors *strange figures having meanings no doubt intelligible to all the tribes* in the vast area watered by these rivers." By the Kamilarai (T. Honery, Journ. Anthrop. Inst. Gt. Brit. and Ireland, 1878, vii., p. 254) they were regarded as "memorials of the dead.

It is much to be regretted that before the last remnant of this fast-disappearing race has passed away, a translation, or at any rate an explanation of these matters, cannot be obtained.

SCIENTIFIC SERIALS.

American Journal of Science, April.—Distance of the stars by Doppler's principle, by G. W. Colles, Jun. This principle may be applied to the calculation of the distances of stars in the manner suggested by Fox Talbot and discussed by Prof. Rambaut. If the velocity of a component of a binary star be measured spectroscopically when it is moving in the line of sight, and its orbit be studied by means of the micrometer, the velocity at any point of the orbit, and hence also the size of the orbit, may be determined. This, divided by its angular magnitude, gives the distance of the system. From theoretical considerations the author calculates the ratio of the mean velocity across the line of sight of a large number of stars distributed equally over the celestial sphere to their mean velocity along the line of sight, and finds this ratio to be $\frac{\pi}{2}$. He then shows that the mean distance of all these stars will be approximately arrived at by multiplying this ratio by the sum of the observed velocities in the line of sight, and dividing by the sum of the observed corresponding angular velocities. Calculating from observations of ninety-five stars in the northern hemisphere, a mean distance of 150·9 light years is obtained, or, taking Vogel's observations only, 80·5 light years.—The radiation and absorption of heat by leaves, by Alfred Goldsborough Mayer. Two leaves of the same species of plant were each glued upon one of the polished tin sides of a Leslie cube. One of the leaves was then painted over with dead-black, and the cube was filled with water kept at 40° C. The radiation from the two leaves was measured by means of a thermopile. It was found that almost all the leaves radiated as well as lampblack. The effect of a thin film of dew was to reduce the radiation to 78 per cent, and to 66 per cent. if the dew stood out in beads upon the surface. The absorption of dark heat rays by leaves interposed as a diaphragm was found to be highly selective. A single elm leaf transmitted 20 per cent. of the radiant heat. A second leaf transmitted 78 per cent. of this, and a third over 83 per cent. of that transmitted by the second. Wild cherry leaves transmitted 9 per cent., and chicory 4 per cent. more heat when their chlorophyll was abstracted by ether or alcohol.—Also papers by Messrs. H. L. Wheeler, W. P. Headden, W. H. Melville, J. F. Kemp, E. A. Smith, R. T. Hill, M. I. Pupin, F. A. Gooch, and P. E. Browning.

THE most important article in the *Botanical Gazette* for December, 1892, is the one to which we have already alluded, in which Mr. R. Thaxter proposes the establishment of a new order of Schizomycetes with the name Myxobacteriaceæ. In that and the following numbers (January—March, 1893) Prof. D. H. Campbell gives his account, most of which we have reprinted, of his visit to the Hawaiian Islands; Mr. G. W. Martin completes his description of the development of the flower and embryo-sac in *Aster and Solidago*; Mr. F. B. Maxwell gives a comparative study of the roots of Ranunculaceæ, in which he makes three types of structure on the basis of the changes which take place through secondary growth. Mr. A. Schneider has a note on the influence of anæsthetics on the transpiration of plants; he finds that both this function and the vitality of protoplasm are both retarded by the action of ether, the protoplasm being finally killed. Prof. J. E. Humphrey gives a full account of the life-history of *Monilia fructigena*, a parasitic fungus which causes great destruction of pears and stone-fruit in America. In an article on non-parasitic bacteria in vegetable tissue Mr. H. L. Russell sums up his conclusion that vegetable, like animal tissues, are normally free from micro-organisms, but that in healthy vegetable tissues many species of bacteria are able to exist for a not inconsiderable length of time. We have also articles describing new species of flowering plants discovered on the American continent, and a *résumé* of the botanical papers read at the New Orleans meeting of the American Association for the Advancement of Science.

IN the numbers of the *Journal of Botany* from January to April the articles of most general interest, in addition to the continuation of others already noticed, are:—A list of the Mycetozoa of South Beds and North Herts, by Mr. Jas. Saunders; Dr. M. T. Masters, on some cases of inversion, in which he gives illustrations of the reversal of the normal relative position of organs or of elements of tissues; a provisional list of the marine algæ of the Cape of Good Hope, by Miss E. S. Barton; a list of the mosses of Guernsey, by Mr. E. D. Marquand; notes on Scotch freshwater algæ, by Mr. W. West, in which two new species are described; notes on the British species of *Campylopus*, a genus of Musci, by Mr. H. N. Dixon. Under the head of "Laboratory Notes," Mr. S. Le M. Moore describes the best way of making Millon's reagent; a new way of demonstrating continuity of protoplasm (Millon's fluid); and the action of cold Millon's fluid on iron-greening tannins, and on cell walls giving proteid reactions.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 2.—"A New Portable Miner's Safety-lamp, with Hydrogen attachment for delicate Gas-testing; with exact Measurements of Flame-cap indications furnished by this and by other Testing-lamps." By Prof. Frank Clowes, D.Sc. (Lond.), University College, Nottingham.

The author, availing himself of his "test-chamber," already described in the Proc. Roy. Soc. vols. l. li. has examined the indications of fire-damp furnished by the different safety-lamps at present in use for testing purposes. These lamps include the ordinary oil-lamp, the Pieler alcohol lamp, the Ashworth benzoline lamp, and the hydrogen-oil lamp, recently devised by the author.

The introduction of a standard hydrogen gas-testing flame into an ordinary oil safety-lamp was first effected by the author, and was described by him in the papers referred to above. But it has now been brought into a far more convenient and portable form; the most recent development of the lamp is described and explained by illustrations in the present paper. The hydrogen gas is stored in a little pocket steel cylinder, under about 100 atmospheres pressure: this can be immediately attached to the safety-lamp when required, and can be made to furnish a standard 10 millimetre hydrogen flame which will burn continuously for forty minutes from the cylinder-supply. The hydrogen is kindled from the oil-flame, without opening the

lamp: and proves to be equal in delicacy and accuracy of testing to Liveing's indicator and other forms of apparatus of precision at present in use. The lamp presents the great advantage of serving at once for lighting, for ordinary gas-testing by the oil-flame, and for most accurate and delicate testing by means of the hydrogen flame.

The paper gives full statements of the results of the flame-cap measurements of the new lamp, and of the lamps mentioned above.

The general conclusions to be drawn from these measurements, and from experience derived from working with the different lamps, are the following:—

(1) The indications of the Pieler lamp begin at the lowest limit of 0·25 per cent., but quickly become too great to be utilised. The thread-like tip extending above the flame for several inches in pure air must not be mistaken for a cap, but it is scarcely distinguishable from the cap given by 0·25 per cent. of gas.

This lamp suffers under the disadvantage that much of the feeble light of the caps is lost by the obstruction of the gauze: the gauze also frequently presents a bright reflecting surface behind the flame, and this renders the observation of the cap impossible. All the other lamps in use are free from these interferences due to the gauze, and if their glasses are blackened behind internally by smoking them with a taper they become well suited for the observation of caps.

(2) The Ashworth benzoline lamp begins its indications doubtfully at 0·5 per cent., the cap thus produced being more distinct, but not greater in height, than the mantle of the flame seen in gas-free air.

But starting with certainty with an indication of 1 per cent., it gives strikingly regular indications up to 6 per cent., and even higher percentages may be read off in a lamp with a long glass.

(3) The standard 10 mm. hydrogen flame gives distinct indications from 0·25 to 3 per cent.; the cap then becomes too high for measurement in the lamp; but by reducing the flame to 5 mm., cap readings may be taken up to 6 per cent. of gas.

The lower indications may similarly be increased by raising the flame to 15 mm.

(4) The oil flame produced by unmixed colza oil gives no indications with percentages below 2. With 1 per cent. of gas the flame from colza mixed with an equal volume of petroleum (water-white) produces an apparent cap, which, though somewhat more intense than the natural mantle seen in gas-free air, is only equal to this mantle in dimensions, and might easily be mistaken for it.

The oil flame, when it is reduced until it just loses its luminous tip, however, gives distinct indications from 3 to 6 per cent.

The largest indications are produced by drawing down the flame *in the presence of the gas*, until a cap of maximum size is obtained.

A carefully regulated oil flame may, therefore, conveniently supplement the hydrogen flame for the indication of gas varying from 3 to 6 per cent., and in the new hydrogen lamp this will be found to be a convenient method to adopt.

The use of colza alone in the oil-lamp is very inconvenient for gas-testing: the wick quickly chars and hardens on the top, and cannot then be reduced without danger of extinction; it can never be obtained satisfactorily in a non-luminous condition. The admixture with petroleum obviates these difficulties.

The use of the hydrogen flame for gas-testing has been proposed, but has never been hitherto carried into practice in an ordinary safety lamp. Careful comparison proves this flame to be superior to the alcohol flame and to all other flames at present suggested. Its indications have never been carefully observed and measured before; they are carefully summarised in the present paper.

It will be readily understood that the main advantages resulting from the use of the hydrogen flame are the following:—

(1) The flame is non-luminous, whatever its dimensions may be, and therefore does not interfere with the perception of the cap.

(2) The flame can always be adjusted at once to standard height and maintained at that height sufficiently long for the completion of the test; whereas other testing flames are constansly varying in dimensions, and most of them cannot be set to standard size at all with any certainty.

Thus a colza-petroleum flame exposed in air containing a low percentage of gas when twice adjusted gave caps of 8 and of 20 mm. The reduced oil flame often fell so quickly that cap-readings with low percentages of gas could not be taken at all.

(3) The caps produced over the hydrogen flame are larger than those produced by any flame of corresponding size.

(4) The size of the hydrogen flame can therefore be so far reduced as to enable it to be used in an ordinary safety-lamp.

The size of the flame may further be suitably varied so as to increase or decrease the height of the cap and thus either increase the delicacy of the test or extend its range.

(5) The hydrogen flame shows no trace of mantle or cap in air free from gas; it resembles the Pieler flame in showing only a slender thread above its apex. The colza-petroleum and the benzoline flames show pale mantles in gas-free air, which may be easily mistaken for a small percentage of gas.

(6) The standard hydrogen flame burns vigorously, it is of fair size, and cannot be extinguished by accident; whereas the reduced flames ordinarily used in testing burn feebly and are readily lost.

(7) Hydrogen is supplied pure and of practically invariable composition; whereas oil and alcohol are apt to vary much in composition, and therefore to give flames whose indications vary with the sample of liquid which is being burnt.

It should be noted that the hydrogen flame is set to standard size *in the presence of the gas*, and therefore yields accurate indications in any atmosphere in which the test is made.

The paper gives full descriptions of the method pursued for obtaining accurate flame-cap measurements in this research. The indications furnished by the new lamp in air containing coal-gas and water-gas are also tabulated; and it is shown that these gases are readily detected when present in small proportions in the air, and their amount is accurately determined. The lamp shows equal delicacy and accuracy in the detection and estimation of petroleum vapour in the air.

When used for the detection of fire-damp the amount of fine coal-dust ordinarily present in the air of the mine caused no interference with the test. The lamp had been proved by use in the coal-mine to be thoroughly practical and easy in its application to gas-testing.

February 16.—"Further Experiments on the Action of Light on *Bacillus anthracis*." IV. By H. Marshall Ward, D.Sc., F.R.S., Professor of Botany, Royal Indian Engineering College, Coopers Hill.

The author has continued his experiments, proving that the light of a winter sun and that of the electric arc rapidly destroy the life of the spores of the anthrax bacillus, and showing that the bactericidal action is really direct, and not due to elevation of temperature, or to any indirect poisoning or starving process incident on changes in the food materials. The evidence goes to prove that the effect is chiefly if not entirely due to the rays of higher refrangibility in the blue-violet of the spectrum.

The experiments have been continued with special reference to these latter points, and confirm the general conclusions in every detail. Not only so, but the further results prove that the inhibitory and deadly effects of direct insolation are not confined to *Bacillus anthracis*, but also extend to other bacteria and even to the Fungi; and throw some light on several problems which have presented themselves during previous investigations.

Experiments with Coloured Screens of Various Kinds.

The author described experiments made during December to February with coloured screens of various kinds; premising that the methods employed in preparing and exposing the plates, &c., have been the same as those referred to in the previous communication.

The results show that when plates are exposed for equal periods behind screens transmitting blue and violet rays, and behind screens which cut off those rays, the spores on the former are killed, whereas no bactericidal action occurs on the latter.

Experiments with Spores and Food Material on Separate Plates.

In order to test still further the accuracy of previous conclusions, that the bactericidal action of the sunlight is direct,

and not due to secondary effects, owing to changes in the food material, the following modifications of the experiments were carried out, and yielded most important and conclusive proofs that the *action of the rays of light is direct on the spores*, and not due to secondary actions owing to changes in the food materials.

Two plates, for instance, of dried spores only are made, and two of agar only, all as before. Then one plate of each kind is exposed to the light, and the others are kept in the dark.

After exposure, the stiff and moist film of *non-exposed* agar is removed from its own plate, and *superposed on the exposed film of dried spores in situ.* Reciprocally, the film of *exposed* agar *is removed*, and *superposed on the non-exposed film of dried spores.*

This prevents any wash or displacement, and ensures at the same time that the agar shall present in contact with the spores that face which was next the source of light.

So far no appreciable effect on the agar has been observed, though the dried spores exposed for an equal period are killed in abundance, as shown by the figure which comes out on culture.

Preliminary Results with the Spores of Fungi.

Results substantially the same as the above are obtainable with other *Schizomycetes*, but it was interesting to see whether anything of kind occurs with the spores of true Fungi. The time of year has, for many reasons, been unfavourable for very numerous experiments, but the results so far are extremely encouraging, and should give a stimulus to close inquiry into the whole subject.

The following species have been examined:—*Penicillium crustaceum*, *Aspergillus glaucus*, *Botrytis cinerea*, *Chalara mycoderma*, *Oidium lactis*, *Nectria cinnabarina*, *Mucor racemosus*, *Saccharomyces pyriformis*, and a "*Stysanus*" conidial form met with some months ago as a saprophyte on *Pandanus*.

On making agar and gelatine plates of these as before, positive results were obtained with *Oidium* (5 cases), *Chalara* (1 case), *Saccharomyces* (4 cases), *Stysanus* (2 cases), and negative results with *Aspergillus* (5 cases), *Penicillium* (2 cases), *Mucor* (2 cases), *Nectria* (4 cases), and *Botrytis* (2 cases).

It seems worth noting that, in all the forms which have given a positive result right off, the spores, as seen in masses, are either hyaline and colourless, or, in the case of the *Stysanus*, with a faint tinge of buff; whereas those which gave negative results are either of some very pronounced colour, as *Aspergillus*, *Penicillium*, and *Nectria*, or (*Mucor* and *Botrytis*) of a dull, yellow-brown hue.

After some theoretical considerations, some practical bearings of the results are thus referred to:—

The establishment of the fact of the bactericidal and fungicidal action of light, dating from Downes and Blunt to now, enables us to see much more clearly into the causes of several phenomena known to practical agriculturists, foresters, hygienists, &c.

It helps to explain, for example, why the soil of a forest should not be exposed to the sun, a dogma long taught in schools; it will also effect our way of regarding bare fallows. It has already been shown how important is its bearing on the purification of rivers, and the reasoning obviously applies to dwellings, towns, &c. The author regards it as probably explaining many discrepancies in the cultures of Schizomycetes and Fungi in our laboratories, and as having a very important bearing indeed on the spreading of plant epidemics in dull weather in the summer, and no doubt this applies to other cases.

That sunshine has something to do with the rarity of bacterial diseases in plants now seems quite as probable as the currently accepted view that the acid nature of the latter accounts for the fact.

If that part of the chlorophyll which absorbs the blue-violet is a screen to prevent the destruction of easily oxidisable bodies, as they are formed in the chloroplasts, we may reconcile several old experimental discrepancies—*e.g.* the behaviour of plants under bichromate and cupric oxide screens.

The author concludes from his experiments, and from numerous other considerations given in the paper, that the colours of spores, pollen grains, &c., are of the nature of colour-screens, and is led to put forward the following hypothesis:—

No plant exposes a reserve store of fatty food materials to the danger of prolonged or intense insolations without a protective colour-screen, calculated to cut out at least the blue violet rays, as these rays would otherwise destroy the reserve substance by promoting its rapid oxidation.

"Studies in the Morphology of Spore-producing Members. Preliminary Statement on the Equisetaceæ and Psilotaceæ." II. By F. O. Bower, D.Sc., F.R.S., Regius Professor of Botany in the University of Glasgow.

Still maintaining the same general views as were put forward in my preliminary statement on the Lycopodinæ and Ophioglossaceæ (Roy. Soc. Proc., vol. l. p. 265), I have now investigated other types from among the Vascular Cryptogams as regards the development of their spore-producing members.

Taking first the Equisetaceæ, the development of the sporangia has been closely followed by Goebel; I find it, however, difficult to accept his conclusions as to the hypodermal origin of the archesporium. On following the early phases of development in *Eq. arvense*, the sporangium is found to be eusporangiate, but the essential parts of the sporangium may be traced in origin to a single superficial cell, the cells adjoining this laterally contributing only to form the lateral portions of the wall. The first division of this cell is periclinal: *the inner resulting cell forms only a part of the sporogenous tissue*; the outer cell undergoes further segmentation, first by anticlinal, then by periclinal, walls, and *the inner cells thus produced are added to the sporogenous tissue, and take part in spore-formation.* The archesporium of *Eq. arvense* is thus shown to be not of hypodermal origin in the strict sense; the same appears to be the case in *Eq. limosum.* Similar additions to the sporogenous tissue by early periclinal division of superficial cells is commonly to be seen in *Isoetes*, and occasional cases, which are difficult to explain in any other way, have been observed in some species of *Lycopodium.* It would thus appear that Goebel's generalisation, that in all the Vascular Cryptogams which he investigated a hypodermal archesporium exists, cannot be retained in the strict sense. The tapetum is derived from the series of cells immediately surrounding the sporogenous mass; it is, however, to be carefully distinguished from certain cells of the sporogenous mass, which also undergo an early disorganisation; for about one-third of the cells of the sporogenous mass do not form spores, but serve physiologically as a diffused tapetum, yielding up their substance to nourish the other young developing spores.

The synangia of the Psilotaceæ have given rise to voluminous discussions. *Tmesipteris* being the genus with the simpler structure, it may be described first. In their earliest stages of development, as lateral outgrowths from the axis, the sporangiophores are not readily distinguishable from the foliage leaves in form or structure, while they occupy a similar position upon the axis. The first appearance of a synangium is as an upgrowth of superficial cells of the adaxial face of the sporangiophore, immediately below its apex; meanwhile the cells of the abaxial side also grow strongly, while the apex itself does not grow so rapidly; so that the organic apex is soon sunk in a groove between these stronger growths. The superficial cells which are to form the synangium undergo periclinal and anticlinal divisions, to form about four layers of cells. All the cells of this tissue are at first very similar to one another, but later two sporogenous masses become differentiated; they are not, however, clearly defined while young from the sterile issue which forms the partition of the synangium, or from the wall. From the arrangement of the cells of these sporogenous masses it seems not improbable that each mass may be referable in origin to a single cell, but this has not been proved to be constantly the case. All the cells of the sporogenous tissue do not arrive at maturity, but here, as in *Equisetum*, a considerable number, serving as a diffused tapetum, become disorganised without forming spores. There is no clearly-defined tapetum in *Tmesipteris.* The leaf lobes begin to be formed almost simultaneously with the synangium, and appear as lateral growths immediately below the apex of the sporangiophore; their further development presents no characters of special note.

The synangium of *Psilotum* originates in essentially a similar manner, being formed from the upper surface of the sporangiophore, immediately below its apex.

On the ground of the observations of internal development, of which the above are the essential features, I agree with the conclusion of Solms that the whole sporangiophore of the Psilotaceæ is of foliar nature, and that the synangium is a growth from its upper surface.

In *Lepidodendron* the sporangium is very large; it is narrow and elongated in a radial direction, extending a considerable distance along the upper surface of the leaf. I have already communicated to the Society the fact that trabeculæ extend in *Lepidodendron* from the base of the sporangium far up into the mass of

spores, and have compared these with the trabeculæ in the sporangium of *Isoetes*. Neither of these sporangia are, however, completely partitioned. I now suggest that comparatively slight modification of the condition in *Lepidodendron* would produce the state of things seen in *Tmesipteris*: if the sterile trabeculæ of *Lepidodendron* were consolidated into a transverse septum, and the apical growth of the sporophyll arrested and taken up by two lateral lobes, the result would be such as is seen in *Tmesipteris*. This is not a mere imaginative suggestion: it proceeds from the observed fact that the septum in *Tmesipteris* is indistinguishable at first from the sporogenous masses. It may further be noted, in connection with the above comparison between *Lepidodendron* and *Tmesipteris*, that the vascular tissues of some of the former appear to correspond more closely to those of *Tmesipteris* than to any other living plant.

Looking at the whole plants of the Psilotaceæ from the point of view above indicated, they are to be regarded as lax strobili, bearing sporangiophores (sporophylls) of rather complex structure. Branching, which is rare in *Tmesipteris*, is common in *Psilotum*, and is to be compared with the branching of the strobilus in many species of *Lycopodium*. In both there are irregularly alternating sterile and fertile zones, not unlike those of some species of *Lycopodium*; at the limits of these arrested sporangia are frequently found. It is not difficult to imagine how such plants as the Psilotaceæ may have originated from some strobiloid type, not unlike that of the genus *Lycopodium*.

March 23.—"The Absolute Thermal Conductivities of Copper and Iron." By R. Wallace Stewart, B.Sc. (London), Assistant Lecturer and Demonstrator in Physics, University College, Bangor. Communicated by Lord Kelvin, P.R.S.

The experiments described in the paper were undertaken with the object of determining the thermal conductivity at different temperatures of iron, and, in particular, of pure, electrolytically deposited copper.

The method adopted was that due to Forbes, but the thermo-electric method of determining temperature was employed, and the bar was protected from currents of air and external radiation by surrounding it by a trough of sheet zinc.

The iron bar used was a square $\frac{3}{4}$-inch bar of ordinary wrought iron; the copper bar was a round $\frac{1}{2}$-inch bar of pure electrolytic copper.

The variation of the specific heat of iron with the temperature was determined by Bunsen's calorimeter; for the specific heat of copper the result given by Bède was taken.

The range of temperature over which the observations extended was from 15° C. to about 220° C.

The final results obtained are indicated by the formulæ given below, and tend to show that for both copper and iron the conductivity decreases with rise of temperature.

Results for Iron in C.G.S. Units.

Diffusivity, κ, at t° C. is given by—

$$\kappa_t = 0{\cdot}208\ (1 - 0{\cdot}00175t),$$

and the absolute thermal conductivity, k, by—

$$k_t = 0{\cdot}172\ (1 - 0{\cdot}0011t).$$

Results for Copper in C.G.S. Units.

Diffusivity, κ, at t° C. is given by—

$$\text{I.}\quad \kappa_t = 1{\cdot}370\ (1 - 0{\cdot}00125t).$$
$$\text{II.}\quad \kappa_t = 1{\cdot}391\ (1 - 0{\cdot}00120t).$$

The mean of these results is taken as—

$$\kappa_t = 1{\cdot}38\ (1 - 0{\cdot}0012t),$$

and the value of the absolute conductivity, k, is then given by—

$$k_t = 1{\cdot}10\ (1 - 0{\cdot}00053t).$$

A table is given at the end of the paper showing the emissive power of the surface of each bar at temperatures between 20° C. and 200° C.

Linnean Society, April 6.—Prof. Stewart, President, in the chair.—The President took occasion to refer to the great loss which botanical science had sustained by the death, on April 4, of Prof. Alphonse de Candolle of Geneva, an announcement which was received with profound regret. Prof. de Candolle was the senior foreign member of this Society, having been elected in May 1850, and was the recipient of the Society's Gold Medal in 1889.—Mr. Clement Reid exhibited and made some remarks upon the fruit of a South European Maple (*Acer monspessulanum*) from an interglacial deposit on the Hampshire coast.—Mr. R. Lloyd Præger, who was present as a visitor, exhibited some rare British plants from the co. Armagh, and gave an account of their local distribution.—A paper was then read by Mr. W. B. Hemsley on a collection of plants from the region of Lhassa, made by Surgeon-Captain Thorold in 1891, and a further collection from the Kuenlun plains made by Captain Picot in 1892. Some of the more interesting plants were exhibited, and critical remarks were offered by Messrs. C. B. Clarke, J. G. Baker, and Dr. Stapf.—Dr. H. C. Sorby gave a demonstration with the oxyhydrogen lantern and exhibited a number of slides which he had prepared of small marine organisms, many of them extremely beautiful, mounted transparently so as to show the internal structure.

Entomological Society, April 12.—Mr. Frederic Merrifield, Vice-President, in the chair.—Sir John T. Dillwyn Llewelyn, Bart., exhibited a number of specimens of Lepidoptera, Coleoptera, and Hymenoptera, all caught in Glamorganshire. The Lepidoptera included two remarkable varieties of *Vanessa io*, both obtained from the same brood of larvæ from which the usual eye-like spots in the hind wings were absent; varieties of *Arctia menthastri*; a long series of melanic and other forms of *Boarmia repandata* and *Tephrosia crepuscularia*; and bleached forms of *Geometra papilionaria*. The Coleoptera included specimens of *Prionus coriarius*, *Pyrochroa coccinea*, *Otiorhynchus sulcatus*, and *Astynomus ædilis*, a large species of Longicornia, which Sir John Llewelyn stated had been handed to him by colliers, who obtained them from the wooden props used in the coal mines, made out of timber imported from the Baltic. Mr. Merrifield, Dr. Sharp, F.R.S., and Mr. Stevens made some remarks on the specimens.—Sir John T. D. Llewelyn inquired whether the name of the moth which had a sufficiently long proboscis to fertilise the large Madagascan species of Orchis, *Angræcum sesquipedale*, was known. Mr. C. O. Waterhouse stated that the collections received at the British Museum from Madagascar had been examined with the view to the discovery of the species, but up to the present it had not been identified.—Mr. H. Goss exhibited, for Mr. Frank W. P. Dennis, of Bahia, Brazil, several nests of Trap-door Spiders, containing living specimens of the spider, and read a communication from Mr. Dennis on the subject. Several photographs of the nests and the spiders were also exhibited. It was stated that Mr. Dennis had found these nests at Bahia in one spot only in a cocoa-nut grove close by the sea.—Mr. McLachlan, F.R.S., read a paper entitled "On species of Chrysopa observed in the Eastern Pyrenees; together with descriptions of, and notes on, new or little-known Palæarctic forms of the genus." The author stated that the species referred to in this paper had been observed by him in the Eastern Pyrenees, in July, 1886, when staying with Mons. René Oberthür. After describing the nature of the district, and its capabilities from an entomological point of view, the paper concluded with descriptions of certain new palæarctic species of the genus. Dr. Sharp, who said that he was acquainted with the district, and Mr. Merrifield made some remarks on the paper.

Paris.

Academy of Sciences, April 10.—M. Lœwy in the chair.—The deaths were announced of Vice-Amiral Pâris and M. Alphonse de Candolle.—On the extinction of torrents and the replanting of the highlands, by M. P. Demontzey. A report on the work done since 1883 towards securing the south of France from its periodical inundation by mountain torrents.—On the loss of electric charge in diffused light and in darkness, by M. Édouard Branly.—Dynamo-electric machinery with compound excitation, by M. Paul Hoho. If a curve be constructed showing how the magnetic excitation of a dynamo-electric machine ought to vary in order that the E.M.F. may remain constant, or may vary according to a given law, it is possible to contrive an excitation such that, if it be also expressed by a curve, the latter will cut the former in any number of points required. Between these points of intersection the two curves nearly coincide. Hence it is possible to produce currents which, between certain limits, do not vary with the speed of the engine. This has been practically realised by means of two separate exciter circuits.—On anomalous dispersion, by M. Salvator Bloch.—General conditions to be fulfilled by registering instruments or indicators; problem of integral synchronisation, by M. A. Blondel. All the instruments in question consist essentially of a movable piece (needle, pencil, membrane, or mirror) susceptible of rectilinear or circular displacement under the simultaneous influence of a

force proportional to the physical quantity to be measured, an opposing force sensibly proportional to the displacement, the inertia of the moving parts, and the damping force, usually proportional to the velocity. The desideratum is that the periodic motion of the moving piece should follow a law as closely approaching that of the phenomenon as possible, so that the deflection may at any instant depart as little as possible from a value equal to the ratio of the force to be measured and the opposing force. This the inventor of the "oscillograph" calls the problem of integral synchronisation, from its analogy to that of simple synchronisation investigated by M. Cornu.—An expression is given for the value below which the damping effect, though made as small as possible, should not be allowed to fall.—On the volatility of manganese, by M. S. Jordan.—Determination of atomic weights by the limit method, by M. G. Hinrichs.—On nitrogenised copper, by MM. Paul Sabatier and J. B. Senderens. Several metals, when newly prepared by means of reduction of their oxides by hydrogen, are able to fix a large quantity of nitrogen peroxide in the cold. The resulting compounds have been termed nitrogenised metals (*métaux nitrés*). In the case of copper, a quantitative analysis of the compound has led to the formula Cu_2NO_2, which corresponds to the fixation upon the metallic surface of the copper of about 1000 times its volume of peroxide at 30° C.—On the isomerism of the amido-benzoic acids, by M. Oechsner de Coninck.—On phtalocyanacetic ether, by P. Th. Muller.—On transpiration in herbaceous grafts, by M. Lucien Daniel.—Exploration of the higher atmosphere; experiment of March 21, 1893, by M. Gustave Hermite. The balloon carrying the registering instruments was constructed of triple gold-beater's skin varnished, its volume being 113 cubic metres. The total weight of the apparatus carried was 17 kgr., including an automatic distributor of inquiry cards, working by a fuse. The ascensional force was 65 kgr., giving a vertical velocity of 8 or 9m. per second. The average velocity of descent was 2·4m., so that the instruments did not suffer. The balloon ascended at 12h. 25m. from Paris-Vaugirard, and landed at Chanvres (Yonne) at 7h. 11m. p.m. The lowest pressure registered was 103 mm., or less than one-seventh of an atmosphere, which corresponds to a height of about 16,000 m. The lowest temperature recorded was −51° C. at 12,500 m., after which the curves of temperature and pressure were interrupted by the freezing of the recording ink. Subsequently, however, the intense solar radiation seems to have thawed the ink, so that the barometric record was taken up again at 16,000 m. and the thermometric curve at −21° C. The fuse ceased to burn after some time, probably owing to the lack of oxygen. The balloon could be followed with the naked eye for three-quarters of an hour, within which it attained its highest altitude. It was white, and brightly illuminated by the sun.—Odoriferous power of chloroform, bromoform, and iodoform, by M. Jacques Passy.—Observations on a series of new forms of snow, collected at very low temperatures, by M. Gustave Nordenskiöld.

BERLIN.

Physiological Society, March 17.—Prof. du Bois Reymond, President, in the chair.—In the discussion which ensued on the communication made at the last meeting of the society, Prof. Zuntz gave the data as to the daily consumption of proteid and fat by the fasting man Cetti, as also the heat produced by their oxidation, from which it appeared that the heat production during his fast was constant.—Prof. Behring gave an account of his further experiments with preventive serum. A portion was mixed with a slight excess of tetanus virus; mice died after inoculation with the mixture. When heated to 65° C. the virus became inert, but not so the serum, thus proving that the respective substances had not exerted any chemical action each on the other. A further new and important fact observed was that tetanus virus—that is, the products of metabolism of tetanus bacilli—made inert by heating to 65° acts preventively towards tetanus infection. Hence the facts known to hold good as to the action of tuberculin in tuberculosis now appear to hold good with regard to tetanus, and should be further investigated in the case of other acute diseases, such as diphtheria, typhus, and cholera.—Dr. Lewy-Dorn gave a full description of his experiments on the question of whether the formation of sweat is the result of a filtrational process. By calculating the capacity of the sweat-glands, and the volume of the sweat-drops secreted, he came to the conclusion that a true new formation of sweat could only be assumed with certainty after a fourfold and copious secretion had taken place. When he now subjected the foot of a cat to an air-pressure far exceeding that of the blood, secretion of sweat was observed on stimulation of the sciatic nerve. On the other hand, when the foot was subjected to a considerably reduced (negative) air-pressure, no formation of sweat was observed. Both these facts are opposed to the filtrational theory of sweat-secretion. Varnishing the skin did not prevent the secretion of sweat resulting from stimulation of nerves or administration of pilocarpine.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Sun, Moon, and Stars, 20th Thousand: A. Giberne (Seeley).—The Field Naturalist's Handbook: Revs. J. G. Wood and T. Wood (Cassell).—A Manual of Dyeing, 3 vols.: E. Knecht, C. Rawson, and R. Loewenthal (Griffin).—A Dictionary of Applied Chemistry, vol. 3: Prof. T. E. Thorpe (Longmans).—The Iron Ores of Great Britain and Ireland: J. D. Kendall (C. Lockwood).—The Glacial Nightmare and the Flood, 2 vols.: Sir H. H. Howorth (S. Low).—Seventh Annual Report of the Bureau of Ethnology, 1885-86: J. W. Powell (Washington).—Contributions to North American Ethnology, vol. 7 (Washington).

PAMPHLETS.—Bibliography of the Athapascan Languages: J. C. Pilling (Washington).—A List of some of the Rotifera of Ireland: Miss Glascott (Dublin).

SERIALS.—Bulletin of the New York Mathematical Society, vol. 2, No. 6 (New York).—Mineralogical Magazine, March (Simpkin).—Natural Science, April (Macmillan and Co.).—Journal of Geology, vol. 1, No. 1 (Chicago).—Mind, April (Williams and Norgate).—Journal of the Royal Agricultural Society, vol. 4, Part 1 (Murray).—Records of the Australian Museum, vol. 2, No. 4 (Sydney).—Congrès Internationaux d'Anthropologie et d'Archéologie Préhistorique et de Zoologie à Moscou, 1892; Matériaux, première partie (Moscou).—Internationales Archiv für Ethnographie, Band 6, Heft 1 (K. Paul).—Illustrations of the Zoology of H.M. Indian Marine Surveying Steamer *Investigator*—Part 1, Crustaceans: J. Wood-Mason; Ditto, Part 1, Fishes: A. Alcock (Calcutta).—Proceedings of the American Philosophical Society, December (Philadelphia).—Journal of the Institution of Electrical Engineers, No. 104, vol. xxii. (Spon).—Engineering Magazine, April (New York).—Memoirs of the American Academy of Arts and Sciences, vol. xii. No. 1 (Cambridge, Wilson).—Journal of the Royal Statistical Society, March (Stanford).—Journal of Anatomy and Physiology, April (Griffin).—Proceedings of the Aristotelian Society, vol. 2, No. 2, Part 1 (Williams and Norgate).—Astronomy and Astro-Physics, April (Northfield, Minn.).—Annals of Scottish Natural History, April (Edinburgh, Douglas).—International Congress of Experimental Psychology, 2nd Session, London, 1892 (Williams and Norgate).—Bulletin de la Société Astronomique de France, sixième année (Paris).—A Manual of Orchidaceous Plants, Part 9 (Veitch).—Encyklopædie der Naturwissenschaften, Dritte Abthg., 13 Liefg., Zweite Abthg., 74 and 75 Liefg. (Breslau, Trewendt).

CONTENTS.

THURSDAY, APRIL 27, 1893.

DYNAMICS IN NUBIBUS.

Waterdale Researches; Fresh Light on Dynamics. By "Waterdale." (London: Chapman and Hall, 1892.)

WHEN St. Paul tried to convince the Athenians that they were mistaken in their philosophy, he probably spoke to them in Greek instead of expecting them to learn Hebrew. "Waterdale" is trying to convince nineteenth century philosophers that it is possible to invent mechanism by which he can attain "the undoubted theoretical possibility of *perpetual motion*," and he does not take the trouble of learning the language of those whom he desires to convince, but insists that they must learn his language, simply because he *professes* to have invented a possible explanation of gravity. He acknowledges that his work would require at least a month's hard work to comprehend, and taunts the scientific world for not gladly spending this time in refuting what most of them have already spent weeks on—namely, refuting the very ingenious inventions of cranks, who think to cheat nature in the dark by some roundabout way of doing what simple considerations show to be impossible. A good month's work to teach him! Let him pay somebody with a reputation whose time is probably worth twelve hundred a year, say a month's time, one hundred pounds, to explain and convince him of the impossibility of his mechanical arrangement. It would take more than a month, however. If human experience is worth much it proves that there is very little use in trying to convince people with missions whether they are right or whether they are wrong. And fortunately so; for, if they are right they will ultimately prevail, and if they are wrong after all they generally do more good than harm by interesting the world in something outside and better than the selfish interests of individuals.

"Waterdale" attributes a good deal of importance to this mechanism. He says in his preface: "Let the scientific reader, I would ask, take the trouble first to go through these calculations, and he will then have some idea as to whether the rest of the book is worthy or not of careful perusal." In the body of the work he invents a very complicated hydrodynamic machine to effect his purpose. He there refers to the very much simpler arrangement described in the appendix, and says: "Unless the possibility" (of perpetual motion) "is admissible, then I must confess that the theory of equal real ponderosity to all matter can *never* be accepted." He acknowledges at the same time "that with full knowledge of the liability to error when dealing with the action of forces," all he can reasonably do is to ask "that . . . pure mathematics be once more applied to the subject." All the same, he asserts that "no disproof can be, or has up to the present been given." "There is no speculation about this, but simple fact, if calculation by figures can be accepted to be true." There are so many things touched on in the work that do not seem in any way necessarily connected with the question of "equal real ponderosity," that it is desirable to show how much interest "Waterdale" feels in this part of his theory in order to justify the paying of any serious attention to what can, on general principles, be so easily disproved. It would certainly not be worth while investigating the question in a scientific journal in order to convince the author of the paradox. He could only be convinced by very painstaking and judicious personal interviews of his error and of the unimportance of this question of equal real ponderosities. It would hardly be worth while investigating the question merely because "Waterdale" attributes importance to it, but it is worth while doing so because others may attribute importance to it, and still more so because "Waterdale's" mechanism is interesting and involves a principle that is intimately connected with the second law of thermodynamics, Boltzmann's hypothesis, and a lot of recondite questions which are puzzling the scientific world, so that it is not much wonder that even a clever and ingenious person should get involved in its meshes, especially when that person is involved in a "mission."

The general idea involved in "Waterdale's" mechanism is as follows:—Suppose a large body (he objects to the word "mass") M and a small one m, and a spring or other means by which kinetic energy can be given to the bodies. If the spring exert a constant force F through a space s_1, it would communicate a velocity V_1 to $(M + m)$, given by the equation—

$$Fs_1 = \tfrac{1}{2}(M + m)V_1^2.$$

If now it work through a distance s_2 it will increase this velocity to V_2, when

$$Fs_2 = \tfrac{1}{2}(M + m)(V_2^2 - V_1^2).$$

So far all is plain sailing. But we may proceed in another way. We may let the spring work against m alone, and then by suitable mechanism use m's kinetic energy to make the combined system $M + m$ move. In this way we might expect to give m a velocity v_1, such that $Fs_1 = \tfrac{1}{2}mv_1^2$, and when this energy was spent on the two bodies $M + m$, they would acquire a velocity V_1 the same as before, given by $\tfrac{1}{2}mv_1^2 = \tfrac{1}{2}(M + m)V_1^2$. Now comes an important assumption, that if the *relative* velocity of m and M be equal to v_1, then by proper mechanism it must always be possible to *increase* M's velocity by V_1, while m's velocity is being reduced to V_1.

Suppose now m_1, moving with velocity V_1, we act upon m by means of the force F, again through the distance s_2 we have for its final velocity v_2—

$$Fs_2 = \tfrac{1}{2}m(v_2^2 - V_1^2).$$

Hence the relative velocity of M and m is $v_2 - V_1$. By choosing $s_2 = 3s_1$, we can arrange that $V_2 = 2V_1$, as it simplifies the further argument. In this case

$$v_2^2 - V_1^2 = 3v_1^2 \text{ or } v_2^2 = 3v_1^2 + V_1^2;$$

$$\therefore v_2 = \sqrt{3v_1^2 + V_1^2},$$

and the relative velocity

$$v_2 - V_1 = \sqrt{3v_1^2 + V_1^2} - V_1,$$

which may be much greater than v_1, if v_1 be much greater than V_1, *i.e.* if m be much smaller than M. This shows that the *relative* velocity after the second blow may be much greater than after the first, even though the two blows were so chosen as that if applied directly to the combined body they would produce equal increments of velocity in that body. Assuming then that a given *relative* velocity can always

produce a given *increase* of velocity in the combined system, it appears by our assumption that, as the *relative* velocity is much greater after the second blow given to m than after the first, the *increase* of velocity of the system produced by this indirect method of applying the second blow will be much greater than by the first, and consequently much greater than the velocity that could be given to the system by applying the blow directly. By reducing the system to its otherwise produced velocity V_2, we could obtain a certain amount of energy, and then repeat the process *ad infinitum*, thus obtaining a continual supply of energy.

An investigator without a mission would be led by this curious result to assume that there must be some mistake in his arguments, and "Waterdale" evidently has some lurking doubts. He sees that it is impossible in the simple case of bodies having only one direction of velocity. Impact can never reduce two bodies of a system to move with the same velocity *and* conserve energy. We cannot have momentum and energy both conserved. Unless M = o we cannot have

$$mv_1 = (M + m)V_1$$
$$\tfrac{1}{2}mv_1^2 = \tfrac{1}{2}(M + m)V_1^2.$$

In order to divide the energy $\frac{1}{2}mv_1^2$ between the two bodies and reduce them both to a common velocity, we require a *third body*, and then what becomes of the principle that seemed so plausible, that the increased velocity that m could impart to M depended on their *relative* velocity only? "Waterdale" sees the hitch all right in the simple case, and consequently, in order to cheat nature by inventing a complicated case in which he hopes that she will get as muddled as himself, he interposes bent channels, a third and fourth body to receive the blows, springy arms to absorb energy, and smooth surfaces to divert the motion. He evidently has some doubts about all this, for, notwithstanding his assertion that "Appendix II. is a mechanical demonstration to prove that by the principle of *velocity* of force, a saving in mechanical work, . . . can be effected," and that "there is no speculation about this, but simple fact," yet he gives only a series of suggestions and vague estimates as *unspeculative proofs*, that the energy spent in bending his springs, in jumping his bodies about, and so forth, is negligible, while in reality it is an important part of his system. That it is so necessarily is proved conclusively by the impossible result he obtains by neglecting it. This is the really interesting principle in the whole matter, that it is not possible to give energy to a system of bodies by giving a series of impulses to some particles of it, to be transmitted to the rest of the system by actions within the system without some part of the energy being spent on internal motions in the system. It is here that the example touches upon the second law of thermodynamics, Boltzmann's hypothesis, and so forth. In order to minimize the effects of these internal vibrations, &c., "Waterdale" argues thus: "Loss No. 2" (giving rise to internal vibrations of his system) "if it arises" (he himself shows that it would, though he overlooks a more important loss), "would be of the nature of internally asserted work." . . . "This loss of work could not be great, for we see by the diagram that the span of work already done when the ball arrives at o is small compared with what it has to do." Notwithstanding his profession of calculating everything he does not calculate here, nor does he calculate with what velocity the ball would rebound after it hit the body B, which ultimately stops it; in fact he omits this important question altogether, and goes to the "third factor, the bending of the arm of the system," which he goes on to say, *without calculation*, "can be almost neglected if we take the tension of elasticity of the arm to be small." "I should say that one-eighth internal loss of work would certainly more than cover everything." This blessed "I should say!" Is it thus that "Waterdale" gives "a mechanical demonstration to prove . . . . a saving in mechanical work"? "There is no speculation about this"! It is "simple fact, if calculation by figures can be accepted as true." Most people would agree that "if calculation by figures can be accepted as true" the velocity that could be given by *any* mechanism to the system indirectly could not be greater than what would give it kinetic energy corresponding to the work supplied. If "Waterdale" will apply a system of levers, springs, &c., acting on the fixed bodies of his system, so as to reduce all the bodies to relative rest, and thereby gives up as hopeless the task of inventing some method by which he can by internal actions alone transfer kinetic energy from one body of a system to the whole of the system without wasting any of it in internal kinetic or potential energy, then he will see how he has to give up the apparently legitimate assumption that the velocity one body of a system can give to the whole system by being itself reduced to relative rest depends *only* on the *relative* velocity of the body and the rest of the system. He will see that it depends also on the velocity of his system relative to those supposed fixed bodies he will require as fulcrums for the mechanism required to transfer the energy of the one body to the rest of the system. He sees that something is required to keep his wedge moving forward. He arranges "that the wedge is supported by a following force . . . during this part." The amount of work required he without calculation *assumes* to be small, and he is probably right here; but it is only one of several losses that he does not *calculate*, and there are others, such as the conditions of impact at the end of the flight of m, that he does not even notice, though this is the very first that should strike a person investigating the subject after he had clearly seen, as "Waterdale" appears to do, that it is here, in the laws of impacts, that the simple case of velocity in one direction and direct impacts fails. It is interesting how cases of this kind illustrate the warming of a gas by compression, the vibrations produced in a bell when struck, and other such cases where energy is given to one part of a dynamical system for this part to distribute amongst the whole, and also how it illustrates the way in which the amount of this internal energy depends on the mobility of the part originally moved. Of course it is all plain enough when the subject is attacked by means of general principles of conservation of energy and momentum, but when the interactions of the different parts of the system are individually considered and the mind distracted by the complexity of the problem, there is real danger that what is important may be overlooked as trivial, as has been done by "Waterdale." He is not to

be blamed for this, but he is to be blamed for putting forward as a proof in which "there is no speculation," as a "simple fact, if calculation by figures can be accepted as true," an investigation in which he acknowledges that he estimates this, that, and the other without calculation.

And after all, what does he require all this elaborate attempt to cheat nature by complex mechanisms for? Simply because he does not understand fully the position of scientific men in respect of the word "mass," and because he has some *à priori* difficulties in his own mind as to how atoms of different masses can require equal quantities of heat to warm them through equal ranges of temperature. He *says* that scientific men say that *because* a cube of gold weighs seven times as much as a cube of aluminium, "it is therefore taken to comprise seven times the quantity of matter; *ergo* it possesses seven times the attractive force, and falls with equal acceleration; *ergo* also it requires seven times the force or work to move it." Now this is a gross libel on scientific men. That it requires seven times the force to move a cube of gold that is required in the same time to generate the same velocity in an equal cube of aluminium is a matter of experience, and is the only reason why it is said that the mass of the gold is seven times as great as the mass of the aluminium, and this is said because the statement is only using the word mass in accordance with the definition of the word. That there is *therefore* seven times the quantity of matter is really no question of *therefore*, for the statement is again merely a definition of the term "quantity of matter," which is, in its scientific use, only another name for mass. Now come questions about gravity, and as no satisfactory explanation of gravity (*pace* Le Sage, Tolver Preston, Osborne Reynolds, "Waterdale," and a host of other theorisers upon this interesting subject) has yet been propounded, no scientific person can rightly say that a body attracts seven times as much as another *because* it has seven times the mass or quantity of matter, for until we know the cause of the attraction we have no right to say that it is *because* of this or that. Hence there is no *therefore* at all put forward by scientific men between "seven times the quantity of matter," "or mass," and "seven times as heavy," or "seven times the attractive force." That a body with seven times the mass of another does as a matter of fact weigh seven times as much is a matter of experience, but that it does so *because* it has seven times the mass is a mere conjecture, and that it is so held by scientific men is proved by attempts having been made to prove by experiment that weight is proportional to mass, and even to find whether weight varies with the direction of the axis of a crystal, &c. "Waterdale" objects to supposing the elementary atoms bulk for bulk to be of equal density, because "we should have to place the atoms in a light substance too far apart," a fairly good reason for investigating the question though not for deciding it. On the other hand he objects to supposing "each atom to be more or less porous—a very incredible hypothesis"—for reasons depending on specific heats to which he evidently attaches some weight, as he harps upon it more than once. Why he should think it so incredible that the atoms may be porous does not clearly appear, for his own atoms, as described in the book, are eminently porous, and it is upon their porosity that his whole explanation of their behaviour to force, and his application of his principle of "velocity of force," and his theories of light and electricity and chemical action and adhesion all depend. He would probably reply that he does not want them *so* porous as all that, though this hardly justifies the epithet "incredible" in respect of a hypothesis he himself holds. Anyway, his serious reason for disbelieving in the unequal masses, or, as he calls it, ponderosities, of atoms is the difficulty he has in seeing how equal quantities of heat can raise unequal masses through equal ranges of temperature. His difficulty rests upon his imagination that he understands fully what the wisest men would probably say they did not understand at all fully, namely, on what property of the atoms of a body temperature depends. He discusses the matter pretty carefully. He says: "How are we to account for the apparent fact that the work of a quantity of heat which is equal to raising weight, 1 of water 1° of temperature—or, in other words, to accelerate, it is to be inferred, the vibrative motion of the whole of its parts in the degree corresponding to one more degree of heat—will be also equal to giving equal acceleration to the entire parts of 8·784 and 30·816, respectively, more matter in the cases of iron and gold?" He here assumes that equal increments of temperature correspond to equal increments of "acceleration" of the atoms. This, if it means anything, is not true, and it is not *à priori* at all likely. Take another place, where he says, ". . . . The fact that a given quantity of imparted heat raised a *really* heavy atom to the same temperature as it would a *really* lighter atom, would indicate that equal temperatures were marked by a slow motion of heavy wedges in respect of a heavy atom, and by a quick motion of light wedges in respect to light atoms."

"Although the same quantity of heat might thus be imparted to the two atoms, it is reasonable to infer that the intensity of the heat, as made apparent to our senses, would not in the two cases be identical." ". . . It is reasonable to infer," on the other hand, that there is some hitch in an argument that depends to any important degree upon such a form of expression as "it is reasonable to infer." Is it not, on the other hand, most reasonable to infer that the blow given by a light body moving quickly would be very much the same as by a heavy body moving more slowly, and that, consequently, the "intensity of heat," as he calls it, would feel the same? In any case a very cursory study of the kinetic theory of gases would point out how there is certainly no incongruity or incredibility, but quite the reverse, in the notion that equal quantities of heat do make light atoms move rapidly and heavy ones slowly; and that, notwithstanding their different atomic velocities, the temperatures of two bodies may be the same. There is no real difficulty in supposing that it requires thirty times as much heat to raise the temperature of water as is required to raise an equal mass of gold through the same range of temperature, if we bear clearly in mind the very complex structure of both water and gold, and all that has to be done by the heat in each case, and at the same time recollect how very little we know of the conditions that determine when two bodies are at the same temperature, *i.e.* that

determine that on the whole no energy shall flow from one to the other when placed in contact or radiating to one another.

There are many other matters treated of in the book, but if one were to take "Waterdale" at his word and judge "whether the rest of the book is worthy or not of careful perusal" by one's experience of Appendix II. and its supposed proof, nobody would read another word, and unless one had a great deal of leisure to devote to speculative conjectures, or were well paid for it, there does not seem much inducement to wade very carefully through it. "Waterdale" professes to explain gravitation by a sort of hotch-potch of Bjerknes' sound wave attractions and Osborne Reynolds's theory founded on dilatancy. He seems to think that any attempt to explain gravitation is very remarkable. "The author would have thought that when the unusual occurrence of the publication of a work announcing the discovery of gravity and other original theories as important arises, that the scientific world would display sufficient interest in the subject as to read and examine the arguments, although the work might be by an unknown pen." "Waterdale" seems ignorant of the fact that the scientific world has been inundated with theories of gravity and other original theories. To mention only a few of the better known ones, there are Le Sage's corpuscular theory, worked out very carefully by Mr. Tolver Preston and Mr. George Forbes. Others founded on wave motion and fluid flow, such as Bjerknes has popularized, and which Mr. Karl Pearson has devoted so much ingenuity to, though he takes refuge in nondynamical suggestions, such as a fourth dimension, which might just as well be introduced as a region in which a convenient series of strings existed to hold atoms together without any action at all going on in our stupid tridimensional space. What the difference is between such a theory and the good old hypothesis of inherent qualities seems difficult to discover. Then there is the suggestion that every atom is connected to every other by means of vortex filaments, though how the poor things work when they get tangled is rather a difficulty here. Finally, there is Osborne Reynolds's interesting theory founded on dilatancy, which very possibly has a future before it, especially if we consider that the ether is probably full of vortices, and that vortices cannot cut one another. These theories almost all suffer from the apparently incurable defect to which "Waterdale's" is also liable, that they give a rate of propagation of gravity comparable with that of light. Parents are proverbially partial to their children, and "Waterdale" probably will cherish his suggestions as very valuable, notwithstanding this and other serious objections. The confident way in which, after pages of suggestions as to what might happen, he states that a current from right to left will produce one effect, while one from left to right will not neutralise it is quite refreshing, but is not an attractive investigation to those who are accustomed to call nothing a proof that is not founded upon something better than suggestions. That gravity is propagated with such amazing rapidity as it is seems to show that it must be an action of the medium to whose *structure* the electromagnetic properties of the ether are due. Such actions are known to exist in a perfect liquid, and it is natural to attribute gravity to such actions. The reasons for attributing great velocity of propagation to gravity are not apparently very well known. The difficulty is owing to the component of the force at right angles to the radius vector that would come in, owing to the aberration of the force, and which would cause an acceleration of areas of planets. This might be partly neutralized by a resisting medium, but hardly completely, especially in the case of comets, because the resisting force would be tangential to the path, while the aberration component would be at right angles to the radius vector. It is possible, by assuming an increase of force due to velocity of approach and a decrease due to recession, to get over this latter difficulty; but even then it is hard to explain the persistent rotation of the earth when the surface is not moving freely as a projectile, and when consequently the supposed exact balance between gravitational acceleration and resistance of medium does not hold. Even then there is the possible suggestion that cohesional and other forces, being similarly propagated in time, would prevent any possible effect being produced by the resisting medium, and so matters return to much as they were at first, and no final answer be given to the questions, "Is gravity propagated in time?" "Does the ether offer resistance to motion?" It remains much in the same position as the question of the motion of the ether at the surface of the earth.

"Waterdale" and others seem to think that fluidity necessarily implies that a medium is divisible into hard or soft particles. No ordinary mind is forced to this conclusion. Most minds look upon water, for instance, as a perfectly continuous medium, any part of which can flow past any other part with perfect freedom. Hardness, softness, and so forth may require structure, but mere fluidity does not. Again, "Waterdale" and others seem to imagine that elasticity essentially involves the *compressibility* of the elastic body: *i.e.* that it must consist of atoms that are themselves compressible. "Waterdale" himself invents a structure for an atom that resists *deformation* without its constituents being themselves compressible, and the existence of vortex rings shows how a perfect liquid can have a real elasticity to deformation given to a part of it by giving it motion without any part being composed of particles, or any part of it being at all compressible.

The rest of "Waterdale's Researches" concern suggestions as to how cohesion, chemical action, light, electricity, &c., may at some future time be explicable by the structure he proposes for the ether, which is to all intents and purposes the same as Osborne Reynolds already has suggested, a whole collection of absolutely hard bodies of different sizes, or, as "Waterdale" suggests, spheres of two different sizes. There is considerable cleverness displayed in the way he has reasoned out for himself such a well-known theorem as that a body moving in a perfect liquid will behave as if its mass were increased, but the labour bestowed upon such a well-known theorem does not entice the reader to try and follow the vague suggestions that follow, and that are much the same as have been over and over again given to show how *every* theory as to the nature of the ether explains a lot of things which can on the face of them be explained by *any* ether through which bodies can move, and upon which they exert pressures. Mixed

up with these plausible suggestions are such things as hypothetical whirls of ether within the solar system that seem, to say the least of them, to require some elucidation as to how comets go through them in every sort of direction without any sensible action of the whirl on the comet.

A person who has brought forth, after enormous labour of thought, a series of theorems concerning the universe, and who is not very familiar with the equally carefully thought-out suggestions of others naturally looks with more favour upon his own children than upon those of others; but, if he is reasonable, and in a reasonable mood, he will not be surprised nor even distressed, because those who look at all these children with critical eyes see very serious defects in all of them, and feel very confident that without great changes no one of them can possibly grow into a second Newton.

VERTEBRATE BIOLOGY.

Text-book of Biology. By H. G. Wells, B.Sc. Lond., F.Z.S. With an Introduction by G. B. Howes, F.L.S., F.Z.S., Assistant Professor of Zoology, Royal College of Science, London. Part I. Vertebrata. (London: W. B. Clive and Co., University Correspondence College Press.)

MR. WELLS'S book is avowedly written mainly for the purpose of helping solitary workers to pass the Intermediate Science examination of the University of London, and it would therefore be unfair to criticise it from a wider point of view. The scope for originality in such a work is naturally somewhat limited, but it is a pleasant surprise to come across one which is far above the average as regards soundness of treatment and method. The author not only possesses a practical knowledge of the greater part of the subject he deals with, but also evidently takes pleasure in it for its own sake, and has a healthy dislike of "that chaotic and breathless cramming of terms misunderstood, tabulated statements, formulated 'tips,' and lists of names, in which so many students, in spite of advice, waste their youth." He states that "the marked proclivity of the average schoolmaster for mere book-work has put such a stamp on study that, in nine cases out of ten, a student, unless he is expressly instructed to the contrary, will go to the tortuous, and possibly inexact, description of a book for a knowledge of things that lie at his very finger-tips" (p. 31); and again, on p. 125, that "it is seeing and thinking much more than reading, which will enable" the student "to clothe the bare terms and phrases of embryology with coherent knowledge." Throughout the book the importance of actual observation is insisted upon.

The present part deals with the Rabbit, Frog, Dog-fish, and Amphioxus, and includes an account of the development of these animals and of the theory of evolution, as well as a number of questions, most of which have been set at the examinations of the London University. The morphological portions are, on the whole good and clearly written, and a fair amount of physiology is also introduced. A syllabus of practical work is given at the end: this would in many respects bear amplifying. The student is not warned that his time will be wasted if he wanders off the direct path of the examination syllabus; and on the contrary, points of general biological interest are referred to here and there, and these go far to show what a good many of our elementary text-books do not—viz. that the London University syllabus, "as at present constituted," affords "considerable scope for efficient biological study." The student, moreover, is told that this "little book is the merest beginning in zoology," and the last paragraph, on p. 131, indicates the aspect of mind with which the author regards his subject.

Twenty-four folding sheets of sketches are inserted in the text, but the figures are, on the whole, exceedingly rough; and though many of them may be found useful as guides, we feel that the student would do better to postpone drawing until his dissections are made, or even copy some of the numerous good figures to be found elsewhere, than to "copy and recopy" these sketches first, as advised by the author.

Numerous inaccuracies and awkward expressions occur, only a few of which can be here mentioned. The terms superior and inferior, as applied to the great veins, are likely to confuse a beginner after reading the definition of the regions of the body given on p. 3. "Metabolism" and "metaboly" occur even in consecutive sentences on p. 23. Peristaltic movement is said to move the food "forward" (p. 41). It is stated that the thyroid is similar in structure to the thymus and to "botryoidal tissue" in general (p. 26), and that the epithelium of the villi, with its striated border, "is usually spoken of as leading towards "ciliated" epithelium (p. 22). It is misleading to say that "a tarsus (tarsalia) *equals* the carpus," and that the vomer of the dog is paired (pp. 38 and 76). As the term "Chordata" is adopted on p. 96, it is unfortunate that the student is told on p. 60 that vertebrata occur in which cartilage is absent, and that Amphioxus possesses the "essential vertebrate features," is "*twisted*, as it were," and that its "vertebral column is devoid of vertebræ:" it is, moreover, inadvisable to use the term "hyoidean" with regard to this animal. On p. 61 "classes" and "orders" are used in a correct and an incorrect sense in the same sentence. The expression, "carotid gland" requires a better explanation on p. 67. The morphology of the cardinals, azygos, and post-caval is incompletely explained (pp. 87, 120, and 124). Several serious mistakes are made with regard to the homologies of the urinogenital apparatus (*cf.*, *e.g.* pp. 92 and 114). Misprints are also fairly abundant throughout.

Most of these faults are, however, such as can be remedied in a future edition, and the book will, we think, serve the purpose for which it was written very satisfactorily. W. N. P.

OUR BOOK SHELF.

Pflanzenleben. Von Anton Kerner von Marilaun. Band II. Geschichte der Pflanzen. (Leipzig und Wien: Bibliographisches Institut.)

THE first volume of this excellent book was reviewed in NATURE, vol. xxxix. p. 507. The present volume, which completes the work, treats of the "history of plants," by which is meant their *development*, in the widest sense, including both ontogeny and phylogeny. The former subject ("origin of descendants") occupies the first 480 pages, while the remainder is devoted to the "history of species."

It is not proposed to enter into any detailed criticism of this volume. Some idea of the scope of the work was given in the former notice; we are glad to hear that an English translation is in preparation, and when this appears a further opportunity will be given for a general account of the whole. In point of interest the second volume is fully equal to the first; there is, however, perhaps more room for adverse criticism of certain parts. Speaking quite generally it may be said that while the "biology," or natural history of the subject is admirable, the morphology is on the whole rather weak. The former, however, is the more important for the general reader, for whom the book is intended.

The account of reproduction begins with the asexual organs of propagation, including spores, buds, and gemmæ. This is succeeded by the much more extensive section on reproduction by fruits, including all sexual processes. The great value of this part lies in the extremely full, and in many respects original, treatment of the fascinating subject of the pollination of flowering plants, to which nearly 300 pages are devoted. Special stress is laid here on the phenomena of *geitonogamy*, or the crossing of different flowers on the same inflorescence, and of *autogamy*, or self-fertilisation of hermaphrodite flowers. The whole account is of the greatest possible interest, and familiar as the subject has now become, innumerable fresh points of view are opened up.

The second part of the volume is on the history of species, including the whole subject of variation. Changes produced by external agencies, such as parasitic fungi, and gall-forming insects, form the subjects of special sections.

As regards the origin of new species, the author, like Prof. Weismann, attributes the greatest importance to sexual reproduction, and especially to cross-fertilisation. He occupies a peculiar position in so far as he believes that hybridisation has played an important part in nature as a source of new forms.

This second part of vol. ii. includes classification, and a fairly full account is given of all the important groups of plants, each cohort, or "Stamm," receiving separate treatment.

Sections on the distribution of species, and on their extinction, conclude the book.

A really good index is added, which will be a great boon to all who wish to make use of the vast store of facts which the book contains. The illustrations, consisting of twenty coloured plates and 1547 figures in the text, reach the same high standard as those of the previous volume.

To the book as a whole the highest praise must be given. No such popular account of the natural history of plants has appeared before. The publication of an English version will be anticipated with great interest.

D. H. S.

Bibliografia Medica Italiana. By P. Giacosa, Prof. straord. di Materia Medica e Chimica fisiologica all' Università di Torino. (Torino-Roma: L. Roux e C., 1893.)

This work is a collection of abstracts of the chief papers bearing on the medical sciences published by various Italian authors during the year 1892. Prof. Giacosa has been aided in his work by several experts, whose names are a sufficient guarantee for the accuracy of the abstracts, such as Profs. Marcassi of Palermo, Maggiora of Modena, and Sperino of Torino. The medical reading public is familiar with the excellent *Jahrberichte* and *Centralblätter* published in Germany, which deals chiefly, though not exclusively, with scientific papers by German authors. There has been a great want of similar publications of Italian work, and Prof. Giacosa's "Bibliografia" is a welcome addition to medical literature. In it will be found abstracts of all the chief Italian papers published in 1892 on parasites and helminthology (zoology), physiology, biological chemistry, pharmacology, histology, human and pathological anatomy, bacteriology and hygiene. The abstracts are done by experts in the particular subject, are short but clear and intelligible, and have the advantage of not being critical.

The Evolution of Decorative Art. By Henry Balfour, M.A., F.Z.S. (London: Percival and Co., 1893.)

It is remarkable that in these days, when the question of "origins" holds a place of commanding importance in almost every department of investigation, comparatively little should have been done to trace the evolution of art back to what Mr. Balfour calls "its very simplest beginning." Mr. Balfour does not, of course, undertake to present in this small book anything like a complete view of the subject. His aim is merely to indicate some of the main conclusions to which he has been led by his own researches. He finds in early art three distinct stages—(1) adaptive; the appreciation of curious or decorative effects occurring in nature or as accidents in manufacture, and the slight increasing of the same by artificial means in order to augment their peculiar character or enhance their value as ornaments; (2) creative; the artificial production of similar effects where these do not occur (imitation or copying); (3) variative; gradual metamorphosis of designs by unconscious and conscious variation. Mr. Balfour brings out admirably the significance of these stages, and it is scarcely necessary to say that the Pitt Rivers collection, of which he is curator, provides him with ample means for the clear and effective exposition and illustration of his ideas.

LETTERS TO THE EDITOR.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of Nature. *No notice is taken of anonymous communications.*]

Palæontological Discovery in Australia.

Many readers of Nature will learn with interest that I have this day received a telegram from Prof. Stirling, of the University of Adelaide, as follows:—

"Made discovery immense deposit fossil remains excavated several nearly complete skeletons Diprotodon besides two thousand bones also large Struthious bird giant Wombat particulars letter."

I need scarcely add that I shall await with impatience the promised particulars of this discovery, which may prove to be one of great importance. Alfred Newton.

Magdalene College, Cambridge, April 21.

An International Zoological Record.

It is much to be regretted that the praiseworthy agitation of this subject, opened by Mr. Minchin (Nature, vol. xlvi. p. 367), has not been continued. There cannot be the slightest doubt of the desirability of such a reform. Possibly the reason why the letters of Mr. Minchin and Mr. Bathers (*ib.* p. 416) have not aroused more interest lies in the fact that they both wrote as recorders. They showed the absurd burdens that the actual system imposes upon the recorders; but they left somewhat in the background the advantages which the great world of zoologists could receive.

However this may be, it is certain that the rank and file of investigators of the present day are supporting an utterly unnecessary burden, and one from which they ardently desire to be freed. Any one who desires to test the sentiment has only to make inquiries among those of his acquaintance. Having myself agitated in this quiet way a method of reform that had occurred to me nearly two years ago, I can hardly doubt that the concourse of opinion is strong enough to effect a radical change, if only concerted action can be taken.

Mr. Minchin and Mr. Bathers have pointed out that the

recorders at present do the same work many times over, and suggest a plan by which it can be avoided. The salient feature lies in separating the duties of recorder and bibliographer, and in having the entire mechanical work *done once* for all concerned in the preparation of the record. The plan is an admirable one, but why thus restrict the blessings of a competent bibliographer? The scheme to which I have alluded in the preceding paragraph simply substitutes a *bibliographical bureau* for the bibliographer, a feature necessitated by the additional duties imposed upon it.

The business of recording a publication according to the latter plan may be referred to *three stages*. Let me suppose the bureau constituted at a centre such as the British Museum, and show its working. The *first stage* of recording is conducted wholly by the central bureau, with such aids from outside as might be found expedient. [I refer to assistants in other countries. In the case of Russia it would be at first probably necessary, although in general to be avoided as far as possible.] In the first place the bureau would make complete lists of all zoological papers as they are published. At intervals of a week, or of two weeks, these lists would be given to the press and printed successively in two forms. One would constitute a pamphlet similar to the bibliographical part of the *Zoolog. Anzeig.*, but would give all the titles *promptly*. The other form in which the list would be printed would have the titles widely spaced, would be printed on strong, stout paper, and would appear in sheets, leaving one side blank. These sheets could then be cut up at will into slips of uniform size and shape to serve further bibliographical elaboration. During the printing of the slips it would have been the duty of the bibliographer to have sorted the titles carefully, and, in the case of larger works and works with ill-characterised contents, it would further have been his duty to have ascertained the *topics* dealt with, so that at the end of the period he would be able to *sort and classify* the 150 titles, which appear at present weekly.

Thereupon the second stage of recording would be begun. Each reviewer would receive at once slips indicating the papers concerning him, together with a page-number in the case in which his topic is only incidentally dealt with. Thus the mechanical labour of the reviewer would be reduced to a minimum. Not merely, however, the reviewers could be thus informed, but *also any specialist whose field of work sufficiently* coincided with one of the divisions of the Record to induce him to subscribe to the series. Thus, for example, a worker on the development of the vertebrate nervous system would find his wants admirably met. The second stage of recording would be carried on wholly by the reviewers, who, however, in addition to writing reviews as at present, would also index the topics of the paper in a more detailed way than would be possible for the bibliographer in his first hasty survey; or this work might be left to the bibliographer, who, in what I have called the third stage, collates the reviews which have been returned to him. The reviewer should also note any incidental observations of interest to other reviewers which the bibliographer may have overlooked.

In stage 3 the bibliographical bureau becomes a bureau of publication, and it is believed that with such an organisation the Record for the year could be very promptly issued. At the same time, however, the bureau would be able, by the use of the slips at its disposal, to embody the indexes furnished by the reviewers (or, possibly better, made out by the bibliographer from their abstracts) in a permanent slip index, which would grow with the years and become a record of inestimable value. This part of the plan alone, I see, has been independently advocated by Mr. Cockerell (NATURE, vol. xlvi. p. 442); but, inasmuch as he overlooked the indefinite multiplication made possible by the use of printed slips, he failed to note the highest use which the bureau can serve. To my mind this consists in *informing the individual investigator of every work which concerns his speciality* by sending him the proper slips.

The value of such a service can hardly be exaggerated. It relieves the individual of endless labour: it gives a completeness to his knowledge of the literature that no individual endeavour could attain; and finally, it saves him the annoyance which indefinite titles occasion him in using the ordinary means of seeking for papers relating to his subject. So long as a fundamental observation on the development of the Wolffian Duct can be published under the title, "Observations on the Lymph," so long as the bulletins announce "Contributions to the Development of the Vertebrates," we have no right to expect authors to have a full mastery of their subject, unless they can receive aid from a central bureau such as I have described.

The expense of maintaining at several points a complete index, such as that in the bibliographical bureau, is not such as to make it infeasible, and I fancy it would be done in several zoological centres. The labour of the bureau would probably assume considerable proportions; but, inasmuch as it would in each case save much more of the scattered and oft-repeated labour of individuals, it would be quite self-supporting. For the perfect working of the scheme it is important that authors should send "extras" to the bibliographer. Mr. Bathers suggests that they would gladly do this if there were only one asking for them instead of a number, as is now the case. Here Mr. Bathers again writes as a recorder. I was unaware that papers were desired, and would not know even where to send a copy. With the scheme I have proposed, also those who now unintentionally withhold their papers would contribute them; for the organisation would at least be well known.

Respecting further details, there is no occasion of bringing these forward now. I may simply add that I have had opportunity of seeing paper slip catalogues in use in a very large scale in the Government service in Russia, and learned that they gave excellent satisfaction. It may be also of interest to any who may further concern themselves with this subject that the present volume of zoological publication is not far from 2000 pages weekly.

I have made inquiries among many of my friends in different countries in respect to their interest in such a plan as I here propose, and it has received such endorsement that I cannot doubt that it affords a remedy for a real evil. I am well aware that such a plan needs to be much modified; but I submit it in this form. I have already a long list of persons and institutions who have promised to subscribe to the slips, could they be obtained at a reasonable price; among others of librarians, who would use them to save copying in making out the "card catalogues" in vogue in America. This support was obtained when the scheme was but little elaborated, and when there was almost no prospect of success. I am confident that were the undertaking once begun the support would be very great. It needs organised action such as the various scientific bodies can give it. Let the British Association appoint a committee and invite others to join them in forming an International Commission, or let them respond should the call come to them. Let all considerations of national pride be set aside. Surely England, with her enormous library and museum facilities, will receive her share.

Leipzig, Germany, April 16. HERBERT H. FIELD.

Lion-tiger and Tiger-lion Hybrids.

SINCE the date of my previous communication on the above subject (see NATURE, p. 390) I have had some correspondence with Mr. John Atkins, son of Mr. Thomas Atkins, the result of which has been not only to clear up several discrepancies which I pointed out as occurring in the previously published accounts by Sir Wm. Jardine and Mr. Griffiths, but moreover it enables me to present for the first time a detailed account of what, so far as I can ascertain, are the only authenticated cases of the interbreeding of a lion and tigress. I am aware of the classical references to the reputed breeding of the leopard and lioness; but that part of the subject I do not propose to discuss now. In the first place I should state that the proprietor of the menagerie, when the first hybrids were seen, was Mr. Thomas Atkins, not "F." or "J. Atkins" as quoted previously. Mr. John Atkins came into possession later on. The parents of the hybrids were the same all through for ten years, from 1824 to 1833, during which period six litters were born. The lion was bred in Mr. Atkins's menagerie from a Barbary lion and a Senegal lioness. The tigress was born in the Marquis of Hastings's collection in Calcutta, and was purchased when about eighteen months old by Mr. T. Atkins from a captain, to whom she had been given by the Marquis. Being of the same age as the lion, she was placed together with him in the same cage, and two years afterwards she proved to be in cub.

The following statement regarding the successive litters has been revised by Mr. John Atkins, and as he has preserved notes of the facts which are recorded, they may be accepted as authentic. I need hardly add that but for his ready and full response to my queries this account could not have been written.

First Litter.—Born October 24, 1824, at Windsor, two males

and one female. Reared by terrier bitch, all died within a year. They were exhibited to King George IV. at the Royal Cottage, Windsor, on November 1, 1824.

Second Litter.—Born April 22, 1825, at Clapham Common; there were three cubs, sexes not recorded. Reared by the mother, as also were all the subsequent litters. They only lived a short time.

Third Litter.—Born December 31, 1826 or '27, at Edinburgh, one male and two females. As stated in the previous paper, the year is given as 1827 in the handbill of the menagerie from which I quoted, and the other references seem to support that date; but Mr. John Atkins says it is given as 1826 in a printed catalogue in his possession.

Fourth Litter.—Born October 2, 1828, at Windsor, one male and two females.

Fifth Litter.—Born May, 1831, at Kensington, three cubs, sexes not recorded. They were shown to the Queen, then Princess Victoria, and to the Duchess of Kent. The whole group performed in a specially constructed cage at Astley's Amphitheatre, and in 1832 were taken by Mr. Atkins for a tour in Ireland. To a separate account of this tour reference has been made in my previous paper.

Sixth Litter.—Born July 19, 1833, at the Zoological Gardens, Liverpool, one male and two females. One, the male, lived for ten years in the gardens. The young male lion-tigers when about three years old had a short mane something like that of an Asiatic lion; the stripes became very indistinct at that age.

Mr. Atkins informs me that there is a badly stuffed specimen of one cub which was about a year old in the Museum at Salisbury, and from Mr. Harmer's letter (see NATURE, p. 413) there is one also in Cambridge.

From the account quoted by him it would seem improbable that that particular specimen, had it survived, could have bred. As a matter of fact I learn from Mr. Atkins that none of them ever did breed, though he does not know of any reason why they should not have done so.

Mr. Atkins thinks that the cubs of the earlier litters died from over-feeding; when he adopted a different treatment he had no difficulty in rearing them.

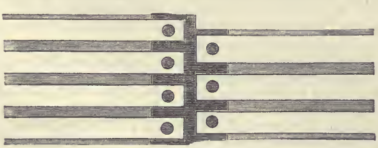
In my previous paper, in the quotation from Griffiths, the word "superfineness" should read "superficies."

This record, it may be noted, while correcting some errors in the previously published accounts, also extends over a period subsequent to all of them. V. BALL.

Science and Art Museum, Dublin, April 15.

Soot-figures on Ceilings.

As the subject of dust-images was recently considered in some interesting letters in NATURE, I wish to record an example of a soot-image which was far more detailed and remarkable than any I have yet seen. The example is to be found on the ceiling of the billiard-room in the Golf Club House at Felixstowe. Abundant soot has been deposited above the lamps by which the table is lighted, and this is distributed so as to map out on the ceiling not only the outline of the joists, but that of the laths and even of the nails by which the ends of the latter are secured. The mark corresponding to the nail-head is certainly much larger



than the latter. I made rom memory a rough sketch of the appearance, which is reproduced in the accompanying woodcut. I may be mistaken in the position of some of the light and dark shades. If the example is as new to others as it was to me it would be interesting to have a photograph of the ceiling before it is again whitewashed. E. B. POULTON.

Oxford, April 17.

THIS phenomenon is often observed, though not often so clearly as in the case noticed by Mr. Poulton. It is due to the same cause as produces the dust-free space seen rising from hot bodies in illuminated smoky air, viz. a peculiar Crookesian (or rather Osborne Reynoldsian) bombardment of sufficiently small dust-particles, in the direction of decreasing temperature, by the extra energy of the gas-molecules on one side See papers by myself and the late Mr. Clark in NATURE (especially July 26, 1883, April 24, 1884, vol. xxix. p. 417, and January 22, 1885), and in Phil. Mag., 1884, Proc. R.I., &c.; also by Mr. Aitken, Trans. R.S. Edin., 1884. And see the remarkable theoretical paper by Prof. Osborne Reynolds on "Dimensional Properties of Gases," Phil. Trans., 1879.

Dust gets bombarded out of hot air on to all colder surfaces. The details of this effect are specially given by Mr. Aitken in NATURE, vol. xxix. p. 322. The badly-conducting plaster of a ceiling is no doubt fully heated by contact with the air below except in places where the conducting power of wood or iron keeps it comparatively cool; hence the picking-out of the pattern. Solid deposit from warm air on to cool surfaces can occur without any actual smoke; *e.g.* it can be noticed above incandescent lamps. OLIVER LODGE.

The Use of Ants to Aphides and Coccidæ.

I HAVE just had an opportunity of seeing Dr. Romanes' interesting work, "Darwin, and after Darwin," and find therein (p. 292) the production of honey-dew by Aphides adduced as a difficulty in the way of the Darwinian theory. I have not paid any particular attention to Aphides, but have lately been much interested in the allied Coccidæ, which, since they produce a similar fluid attracting ants, may be considered to offer a parallel instance. Both Coccidæ and Aphides suffer from many predaceous and parasitic enemies, and there seems to be no doubt that the presence of numerous ants serves to ward these off, and is consequently beneficial. There is an interesting Coccid, *Icerya rosæ*, which I find on Prosopis here, and on more than one occasion I have been unable to collect specimens without being stung by the ants. At the present moment some of these Iceryæ are enjoying life, which would certainly have perished at my hands, but for the inconvenience presented by the numbers of stinging ants.

Belt and Forel have also written on the protection of Coccidæ by ants ("Naturalist in Nicaragua;" and *Bull. Soc. Vaud.*, 1876). Maskell has given an account of the honey-dew organ of Coccidæ, from which it appears that it is something more than a mere organ for the excretion of waste products. This author also figures some of the fungi which grow on honey-dew, and it may well be that these also serve to prevent the attacks of enemies. When, as we sometimes see in Jamaica, the leaves appear to be coated with soot (*Antennaria robbinsii* is the fungus), it cannot be so convenient for coccinellid larvæ, Chrysopa larvæ, &c., to crawl about on them in search of Coccidæ.

Jamaica, April 3. T. D. A. COCKERELL.

Blind Animals in Caves.

IN his last letter (p. 537) Mr. J. T. Cunningham states that the "early stages" of the European Proteus have not yet been obtained. This assertion is incorrect. In 1888 and 1889 the oviposition and development have been described by E. Zeller (*Zool. Anz.*, 1888, No. 290, and *Jahresh. Ver. Naturk. Württ.*, xlv., 1889, p. 131, plate iii.), who gives a coloured figure of the larva, and particularly refers to the development of the eyes. As early as 1831 (Oken's "Isis," 1831, p. 501) Michahelles remarked that the eyes in young specimens are more distinct and somewhat larger than in the adult. G. A. BOULENGER.

OBSERVATIONS IN THE WEST INDIES.[1]

HERE we are back at Nassau for the third time, and thinking you might be interested to hear of my cruises, I send you a short sketch of our trip. The first time we left Nassau we entered the Bahama Bank at Douglass Channel and crossed the bank to North Eleuthera, where we examined the "Glass Window" and the northern extremity of Eleuthera, we then sailed along the west shore of the island close enough to get a good view of its characteristics as far as Rock Harbour at the

[1] A letter from Alexander Agassiz to J. D. Dana; dated Steam Yacht *Wild Duck*, Nassau, March, 1893. Printed in the *American Journal of Science* for April, and communicated to NATURE by the author.

southern end. We steamed out into Exuma Sound through the Powell Channel and round the southern end of Eleuthera to little San Salvador, and the north-west end of Cat Island, where are the highest hills of the Bahamas. We then skirted Cat Island along its western face, rounded the southern extremity and made for Riding Rocks on the Western side of Watling's Island. We circumnavigated Watling, passed over to Rum Cay, then to northern part of Long Island, visiting Clarence Harbour; next we crossed to Fortune Island, and passed to the east side near the northern end of the island on the Crooked Island Bank. From there we crossed to Caicos Bank, crossing that bank from French Cay to Long Island, passed by Cockburn Harbour and ended our eastern route at Turks Island; from there we shaped our course to Santiago de Cuba to coal and provision the yacht. We were fortunate enough to strike Cape Maysi a short time after daylight, and I thus had a capital chance to observe the magnificent elevated terraces (coral reefs) which skirt the whole of the southern shore of Cuba from Cape Maysi to Cape Cruz and make so prominent a part of the landscape as seen from the sea. We were never more than three miles from shore and had ample opportunity to trace the course of some of the terraces as far as Santiago, and to note the great changes in the aspect of the shores as we passed westward due to the greater denudation and erosion of the limestone hills and terraces to the west of Cape Maysi, which seems to be the only point where five terraces are distinctly to be seen. The height of the hills east of Pt. Caleta, where the terraces are most clearly defined, I should estimate at 900 to 1000 feet; though the hills behind the terraces, which judging from their faces are also limestone, reach a somewhat greater height, perhaps 1100 to 1200 feet.

After coaling at Santiago de Cuba we visited Inagua, and next steamed to Hogstey Reef, a regular horseshoe-shaped atoll with two small cays at the western entrance. There we passed three days studying the atoll. This to me was an entirely novel experience; to be at anchor in 3 fathoms of water 45 miles from any land with water 900 fathoms within three miles outside, surrounded by a wall of heavy breakers pounding upon the narrow annular reef which sheltered us. I made some soundings in the lagoon and on the slope of reef outside. From there we returned to Crooked Island Bank to the westward of which I also made some soundings to determine the slope of the Bank. We next again visited Long Island, taking in the southern and northern ends which I had not examined. From there we passed to Great Exuma, stopping at Great Exuma Harbour and sounding into deep water on our way out to Conch Cut when we sailed west crossing the Bank to Green Cay. From there we made the southward face of New Providence, and before going into Nassau Harbour made some trials in deep water in the Tongue of the Ocean with the *Tanner* deep-sea townet in 100 and 300 fathoms, depth being 700 fathoms—after which we returned to Nassau. I had on board a Tanner sounding machine kindly loaned me for this trip by Colonel McDonald of the Fish Commission, and some deep-sea thermometers were also kindly supplied by him and by Prof. Mendenhall, the superintendent of the U.S. Coast Survey. I supplied myself with a number of Tanner deep-sea townets and with a supply of dredge and of townets and carried on board a Yale and Towne patent winch for winding the wire rope which I used in my dredging and towing in deep water. The yacht was provided with a steam capstan and by increasing its diameter with lagging we found no difficulty in hauling in our wire rope at the rate of 8 min. to 100 fathoms. I carried 600 fathoms of steel wire dredging rope with me of the same dimensions which I had used on the *Blake* and which has also been adopted on the *Albatross*. During our second cruise we steamed from Nassau for Harvey Cay crossing the Bank from north to south to Flamingo Cay, and then to Great Ragged Cay, from which we took our departure for Baracoa. At Baracoa I hoped to be able to ascend the Yunque; unfortunately I had to give up my trip owing to the desperate condition of the roads. From Baracoa we steamed close to the shores to the westward, touching at Port Banes, Port Padre, Cay Confites, Sagua, Cape Frances, Cardenas, Matanzas, and finally ending at Havana. This trip was a continuation of the observations we made on the south coast of Cuba and enabled me to trace the gradual disappearance of the terraces from Baracoa to Nuevitas, and their reappearance from Matanzas to Havana, from the same causes which evidently influenced their state of preservation from Cape Maysi west. I also got a pretty clear idea of the mode of formation of the fine harbours found on the northern coast of Cuba to the eastward of Nuevitas, and of the mode of formation of the extensive systems of cays reaching from Nuevitas to Cardenas and which find their parallel on the south coast of Cuba from Cape Cruz to Cape Corrientes. After refitting at Havana we left for Nassau. Both on going into Havana and on leaving we spent the greater part of a day in towing with the Tanner net. I thought I could not select a better spot for finally settling the vertical distribution of pelagic life than off Havana which is in deep water—900 fathoms—close to land, on the track of a great oceanic current, the Gulf Stream, noted for the mass of pelagic life it carries along its course. We towed in 100, 150, 250, and 300 fathoms and on the surface at or near the same locality, and I have found nothing to cause me to change the views which I expressed in my preliminary reports of the *Albatross* expedition of 1891. Nowhere did I find anything which was not at some time found also at the surface. At 100 fathoms the amount of animal life was much less than in the belt from 100 fathoms to the surface. At 150 fathoms there was still less and at 250 fathoms and 300 fathoms the closed part of the Tanner contained *nothing*. At each one of these depths we towed fully as long as was required to bring the net to the surface again. Thus we insured before the messenger was sent to close the lower part of the bar as long a pull through water as the open part of the net would have to travel till it reached the surface, giving the fauna of a horizontal column of water at 100, 150, 250, and 300 fathoms of the same or greater length than the vertical column to the surface for comparison of their respective richness. From Havana we steamed to Cay Sal Bank, visited Cay Sal, Double-headed Shot Cays, Anguila Islands, and then crossed over to the Great Bank to the west of Andros Island. The bottom of this bank is of a most uniform level, 3 and $3\frac{1}{2}$ fathoms for miles and then very gradually sloping to the west shore of Andros, so that we had to anchor nearly six miles from the "Wide Opening" of the central part of Andros which we visited. The bottom consists of a white marl, resembling when brought up in the dredge newly mixed plaster of Paris, and having about its consistency just as it begins to set. This same bottom extends to the shore; and the land itself, which is low where we went on shore not more than 10 to 15 inches above high-water mark, is made up of the same material, which feels under foot as if one were treading upon a sheet of soft india rubber; of course on shore the marl is drier and has the consistency of very thick dough. It appears to be made up of the same material as the æolian rocks of the rest of the Bahamas, only that it has become thoroughly saturated with salt water, and in that condition it crumbles readily and is then triturated into a fine impalpable powder almost like deep sea ooze which covers the bottom of the immense bank to the west of Andros. After leaving Andros we crossed the bank again to Orange Cay and followed the eastern edge of the Gulf Stream to see Riding Rocks, Gun Cay, and the Beminis. We then passed to Great Isaac, where we saw some huge

masses of æolian rocks which had been thrown up along the slope of the cay about 80 feet from high-water mark to a height of 20 feet. One of these masses was 15′ 6″ × 11″ × 6′. We then kept on to Great Stirrup Cay coasting along the Berry Cays, crossed over to Morgan's Bluff, on eastward of Andros down to Mastic Point on the same Sound, and then returned to Nassau.

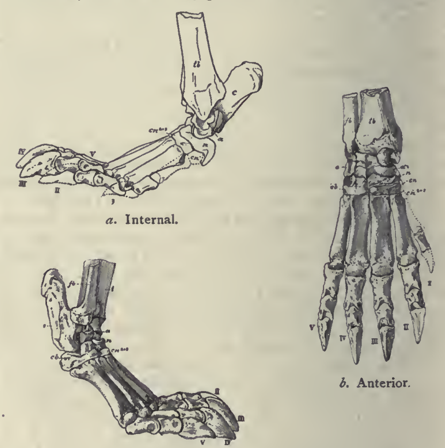
The islands of the Bahamas (as far as Turks Island) are all of æolian origin. They were formed at a time when the Banks up to the 10-fathom line must have been practically one huge irregularly-shaped mass of low land, from the beaches of which successive ranges of low hills, such as we still find in New Providence, must have originated. After the islands were thus raised there was an extensive gradual subsidence which can be estimated at about 300 feet, and during this subsidence the sea has little by little eaten away the æolian lands, leaving only here and there narrow strips of land in the shape of the present islands. Inagua and Little Inagua are still in the original condition in which I imagine such banks as the Crooked Island Banks, Caicos Banks, and other parts of the Bahamas to have been; while the process of disintegration going on at the western side of Andros shows still a broad island which will in time leave only the narrow eastern strip of higher land (æolian hills) on the western edge of the tongue of the ocean. Such is the structure also of Salt Cay Bank which owes its present shape to the same conditions as those which have given the Bahamas their present configuration. My reason for assigning a subsidence of 300 feet is the depth of some of the deep holes which have been surveyed on the bank and which I take to be submarine blow-holes or caverns formed in the æolian limestone of the Bahama hills when they were at a greater elevation than now. This subsidence explains satisfactorily the cause of the present configuration of the Bahamas, but teaches us nothing in regard to the substratum upon which the Bahamas were built. The present reefs form indeed but an insignificant part of the topography of the islands and have taken only a secondary part in filling here and there a bight or a cove with more modern reef rock, thrown up against the shores so as to form a coral reef beach such as we find in the Florida Reef. I have steamed now nearly 3300 miles among the Bahamas, visiting all the more important points and have made an extensive collection of the rocks of the group.

I hoped to have made also a larger number of deep soundings than I have been able to take; unfortunately the trades were unusually heavy during the greater part of my visit to the Bahamas, greatly interfering with such work on a vessel no larger than the *Wild Duck*—127 feet on the water line. For the same reason the number of deep-water pelagic hauls was also much smaller than I hoped to make, as in a heavy sea the apparatus would have been greatly endangered. It is a very different thing to work at sea in a small yacht like the *Wild Duck* or in such vessels as the *Blake* and the *Albatross* of large size and fitted up with every possible requirement for deep sea work. The *Wild Duck*, on the other hand, was admirably adapted for cruising on the Bahama Banks, her light draught enabling her to go to every point of interest and to cross and recross the banks where a larger vessel could not follow. I am under the greatest obligations to my friend Mr. John M. Forbes for having so kindly placed his yacht at my disposal for this exploration, and I hope soon after my return to Cambridge to publish more in detail the results of this examination of the structure of the Bahamas.

ARTIONYX—A CLAWED ARTIODACTYLE.

If any further evidence were needed to disprove Cuvier's famous generalisation, it is found in the recently discovered hind foot of Artionyx. In this foot each of the digits with all the phalanges are modified very much as in the primitive bears, and combined with metatarsals and an ankle joint almost identical with those of the pigs. The termination of the limb in claws would have led Cuvier to predict that the whole skeleton and the dentition was of a clawed or carnivorous type, whereas in this animal we find the foot alone belongs to two types as widely separated as can be, and the probabilities are that the skeleton and teeth are also mixed in character.

The foot of Artionyx was found last summer by the American Museum party under Dr. Wortman, in the same beds with the remarkable Protoceras recently described in NATURE. It belonged to an animal about the size of a peccary. The terminal claws were first exposed, and although found uncleft, they at once suggested a reference to Chalicotherium, for which the party was keeping a sharp look-out; but a further removal of the matrix showed a pes of an entirely distinct character. In the foot of *Chalicotherium magnum* of the Upper Miocene of France we find three toes, thus odd in number, but not strictly perissodactyle, for the largest is



a. Internal. *b.* Anterior. *c.* External.

Right hind foot of *Artionyx gaudryi.*

not the median but the outer toe. Above the toes is an ankle joint of a modified perissodactyle type, that is, the astragalus is grooved upon its tibial side, and flattened where it rests upon the navicular. The navicular and cuneiforms are also flattened, so that the foot must have been placed somewhat at an angle with the leg, as it is in the Sloths. In Artionyx, on the other hand, there are five digits; the first, or thumb, was a dew-claw, very much shorter than the rest; the remaining four, as shown in *b* of the figure, are nearly symmetrically placed in pairs on either side of the median line, precisely as in the Artiodactyla. This has suggested the name of the animal, its even-numbered toes terminating in claws. Above these elements we have a coalescence of the outer and middle cuneiforms as in many Artiodactyla. The cuboid, navicular, astragalus, and calcaneum, are also modified precisely as in the artiodactyles. The fibula comes down upon the heel bone, and there is the characteristic double hinge. The tibia is strongly interlocked on the outer side of the astragalus. The three accompanying cuts exhibit the peculiar features of this foot; the side views showing that the animal was digitigrade like the cats, and not plantigrade like the bears, although the claws were more of the bear than the cat type.

The discovery of this foot is one of those complete surprises which render palæontological research so fascinating. The existence of such a type was not even suspected, for nothing at all similar has ever been found before. We were daily expecting to find remains of Chalicotherium in the Lower Miocene of America, but no one could have anticipated the complete counterpart in foot structure which this animal exhibits. Of course it will remain an open question whether Artionyx is actually related to the other type until we procure more of its skeleton, and especially of its teeth. This discovery seems to support Cope's opinion that Chalicotherium represents a distinct order—the Ancylopoda, including animals of an ungulate type of skeleton, with unguiculate phalanges. The writer has recently suggested that this order may have been given off from the most primitive hoofed mammals, the Condylarthra, at a period when they still exhibited many of the characters of their clawed ancestors. If this supposition is correct, and Artionyx proves to be a member of the Ancylopoda, it will very possibly present a unique double parallelism with the subdivisions of the Ungulata, Chalicotherium representing an odd-clawed division—the Perissonychia, and Artionyx an even-clawed division—the Artionychia—these divisions being parallel with the perissodactyle and artiodactyle ungulates. This is advanced as a provisional hypothesis, pending the discovery of additional remains.

HENRY F. OSBORN.

THE HODGKINS FUND PRIZES.

IN October, 1891, Thomas George Hodgkins, Esq., of Setauket, New York, made a donation to the Smithsonian Institution, the income from a part of which was to be devoted "to the increase and diffusion of more exact knowledge in regard to the nature and properties of atmospheric air in connection with the welfare of man."

With the intent of furthering the donor's wishes, the Smithsonian Institution now announces the following prizes to be awarded on or after July 1, 1894, should satisfactory papers be offered in competition:—

1. A prize of 10,000 dollars for a treatise embodying some new and important discovery in regard to the nature or properties of atmospheric air. These properties may be considered in their bearing upon any or all of the sciences—*e.g.* not only in regard to meteorology, but in connection with hygiene, or with any department whatever of biological or physical knowledge.

2. A prize of 2000 dollars for the most satisfactory essay upon (A) the known properties of atmospheric air considered in their relationships to research in every department of natural science, and the importance of a study of the atmosphere considered in view of these relationships; (B) the proper direction of future research in connection with the imperfections of our knowledge of atmospheric air, and of the connections of that knowledge with other sciences. The essay, as a whole, should tend to indicate the path best calculated to lead to worthy results in connection with the future administration of the Hodgkins foundation.

3. A prize of 1000 dollars for the best popular treatise upon atmospheric air, its properties and relationships (including those to hygiene, physical and mental). This essay need not exceed 20,000 words in length; it should be written in simple language, and be suitable for publication for popular instruction.

4. A medal will be established, under the name of "The Hodgkins Medal of the Smithsonian Institution," which will be awarded annually or biennially, for important contributions to our knowledge of the nature and properties of atmospheric air, or for practical applications of our existing knowledge of them to the welfare of mankind. This medal will be of gold, and will be accompanied by a duplicate impression in silver or bronze.

The treatises may be written in English, French, German, or Italian, and should be sent to the secretary of the Smithsonian Institution, Washington, before July 1, 1894, except those in competition for the first prize, the sending of which may be delayed until December 31, 1894.

The papers will be examined and prizes awarded by a committee to be appointed as follows:—One member by the secretary of the Smithsonian Institution, one member by the President of the National Academy of Sciences, one by the President *pro tempore* of the American Association for the Advancement of Science, and the committee will act together with the Secretary of the Smithsonian Institution as member *ex officio*. The right is reserved to award no prize if, in the judgment of the committee, no contribution is offered of sufficient merit to warrant an award. An advisory committee of not more than three European men of science may be added at the discretion of the Committee of Award.

If no disposition be made of the first prize at the time now announced, the Institution may continue it until a later date, should it be made evident that important investigations relative to its object are in progress, the results of which it is intended to offer in competition for the prize. The Smithsonian Institution reserves the right to limit or modify the conditions for this prize after December 1, 1894, should it be found necessary. Should any of the minor prizes not be awarded to papers sent in before July 1, 1894, the said prizes will be withdrawn from competition.

A principal motive for offering these prizes is to call attention to the Hodgkins Fund and the purposes for which it exists, and accordingly this circular is sent to the principal universities and to all learned societies known to the Institution, as well as to representative men of science in every nation. Suggestions and recommendations in regard to the most effective application of this fund are invited.

It is probable that special grants of money may be made to specialists engaged in original investigation upon atmospheric air and its properties. Applications for grants of this nature should have the indorsement of some recognised academy of sciences or other institution of learning, and should be accompanied by evidences of the capacity of the applicant in the form of at least one memoir already published by him based upon original investigation.

To prevent misapprehension of the founder's wishes it is repeated that the discoveries or applications proper to be brought to the consideration of the Committee of Award may be in the field of any science or any art without restriction, provided only that they have to do with "the nature and properties of atmospheric air in connection with the welfare of man."

Information of any kind desired by persons intending to become competitors will be furnished on application.

All communications in regard to the Hodgkins Fund, the Hodgkins Prizes, the Hodgkins Medals, and the Hodgkins Fund Publications, or applications for grants of money, should be addressed to S. P. Langley, Secretary of the Smithsonian Institution, Washington, U.S.A.

S. P. LANGLEY,
Secretary of the Smithsonian Institution.

Washington, March 31, 1893.

THE SOLAR ECLIPSE.

THE telegrams relating to the total solar eclipse of April 16 indicate that the observations at the various centres were carried on under very favourable conditions. The Senegal party—which will be home next week—was

evidently remarkably successful. Prof. Thorpe, who was in charge of this expedition, sent to Lord Kelvin the following telegram:—"April 19, 1893. Thorpe to President Royal Society, Burlington House, London. Eclipse successfully observed at Fundium. Position good, weather fine, very slight haze. Slit spectroscope good, but mainly prominence lines; calcium and hydrogen seen projected on moon. Thirty prismatic camera photographs, eighteen excellent; mainly prominence lines; corona lines doubtful. Ten coronograph pictures, six very good. Photometric work successful; twenty comparisons with equatorial, eleven with integrating apparatus. Deslandres and Colculesco also observed at Fundium, with good results. No word from Bigourdan at Joal. Health of expedition good. Blonde leaves for Teneriffe to-morrow.—Thorpe."

With regard to the work of the same expedition, a correspondent of the *Times* telegraphed from Bathurst on April 19:—"The solar eclipse was successfully observed at Fundium, Senegal. The weather was fine, with only a very slight haze. The results of the slit spectroscope were good. Thirty prismatic camera photographs were taken, eighteen of which are excellent, while of ten coronograph pictures six are very good. The photometric work was successful, and twenty comparisons were taken with the equatorial and eleven with the integrating apparatus. The French astronomers, MM. Deslandres and Colculesco also made observations at Fundium with good results. The health of the expedition is excellent."

Last week we gave the substance of a telegram regarding Prof. Pickering's observations at Minasaris. The *New York Herald* has published a telegram from Valparaiso, containing the following supplementary information as to Prof. Pickering's work:—"The sunlight changed during the period of totality and presented a pale yellow hue. A faint chill was perceptible in the air. The photographic results with the differential spectroscope give twenty lines in the solar atmosphere at a time of 34 seconds previous to totality. Two rays of light were seen issuing from the cusps, their terminal points corresponding to the horns of the new moon. The cusps were in violent motion. The corona showed a conical structure with a network of fine filaments visible to the naked eye. Four light streamers from the corona were noticeable, and seven prominences were observed, which latter were estimated to attain a height of 80,000 miles. The integrating spectroscope showed one red, one yellow, and one blue line and two green lines in the corona. The prominences were well photographed."

The following is a Reuter's telegram from San Francisco, relating to the work of the American expedition to Chili:—"Prof. Holden, the director of the Lick Observatory, has received a telegram from Prof. Schaebele, the leader of the American expedition to Chili, stating that his observation of the sun's total eclipse was successful. The drawings of the corona made a year ago by Prof. Schaebele were found to be a true representation of the corona actually visible in the present eclipse. Fifty photographs were secured by means of the three telescopes used by the observers. One of these gave an image of the sun 4 in. in diameter, and the corona covered a plate 18 by 22 in."

NOTES.

All the most essential arrangements have now been made for the Nottingham meeting of the British Association. The first general meeting will be held on Wednesday, September 13, at 8 p.m., when Sir Archibald Geikie will resign the chair, and Dr. J. S. Burdon Sanderson will assume the presidency and deliver an address. On Thursday evening, September 14, there will be a soirée; on Friday evening a discourse will be delivered by Prof. Arthur Smithells on "flame"; on Monday evening Prof. Victor Horsley will deliver a discourse "on the discovery of the physiology of the nervous system"; on Tuesday evening there will be another soirée; and on Wednesday afternoon, September 20, the concluding general meeting will be held. Excursions to places of interest in the neighbourhood of Nottingham will be made on the afternoon of Saturday, September 16, and on Thursday, September 21. The following will be the presidents of sections:—A (Mathematical and Physical Science), Prof. R. B. Clifton, F.R.S.; B (Chemistry and Mineralogy), Prof. J. E. Reynolds, F.R.S.; C (Geology), Mr. J. J. H. Teall, F.R.S.; D (Biology), Rev. H. B. Tristram, F.R.S.; E (Geography), Mr. H. Seebohm; F (Economic Science and Statistics), Prof. J. S. Nicholson; G (Mechanical Science), Mr. Jeremiah Head; H (Anthropology), Dr. Robert Munro.

The Chemical Society will hold on Friday, May 5, a Hofmann Memorial Meeting. Addresses will be delivered by Lord Playfair, Sir F. A. Abel, and Dr. W. H. Perkin.

The annual dinner of the Royal Geographical Society will take place on Saturday, May 13, at the Whitehall Rooms, Hôtel Métropole, Sir Mountstuart E. Grant Duff in the chair.

At the recent Graduation Ceremony of the University of St. Andrews the honorary degree of LL.D. was conferred on Prof. Henry E. Armstrong, Ph.D., F.R.S., in recognition of his eminent services to organic chemistry.

On Thursday, May 4, the forty-first anniversary of the election of the Secretary of the Institution of Civil Engineers as an Associate, the first "James Forrest" lecture will be delivered by Dr. W. Anderson, F.R.S., the subject being "The Interdependence of Abstract Science and Engineering."

The City and Guilds of London Institute has forwarded to county councils throughout the kingdom, and to the secretaries of technical schools in connection with the Institute, a circular letter indicating various ways in which it has improved and enlarged the scope of its technological examinations. Among the alterations may be mentioned the addition of practical tests in photography, boot and shoe manufacture, goldsmiths' work, mechanical engineering, and other subjects; the subdivision of many subjects into sections to suit the requirements of different branches of the same trade; and the addition of examinations in such subjects as manual training and dressmaking. After careful consideration of the difficult questions involved in the organisation, for the first time, of a system of inspection of technical classes, the Committee of the Institute have adopted a scheme, and are prepared to receive applications from county councils or school committees for the inspection of classes in technical (other than agricultural) subjects, and also for special reports on the results of the examination of the students of separate classes registered under the Institute.

It has been resolved by the Council of the Zoological Society of London to award the Society's Silver Medal to Donald Cameron, of Lochiel, and John Peter Grant, of Rothiemurchus, in recognition of the efforts they have made to protect the Osprey (*Pandion haliätus*) in Scotland. The osprey, formerly common in many parts of the British Islands, has become so rare of late years that it is stated that only three pairs of this bird have been known to breed in this country for some years past.

The hon. secretaries of the Australasian Association for the Advancement of Science are sending out invitations to the leading scientific societies in Europe drawing attention to the meeting of the Association, which will be held in Adelaide, commencing on September 25 next. Sydney, Melbourne, Christchurch, and Hobart are the places in which the previous meetings of the Association have been held. The meeting in

Adelaide will be presided over by Prof. Ralph Tate, of the University in that city.

THE late Admiral Marquis Ricci of Genoa, formerly Minister of Marine of the Kingdom of Italy, has left a large sum, estimated to amount to about three million lire (£120,000) to the authorities of his native city, for the purpose of founding a Scientific Institution. It is believed that this is likely to be devoted to a new site and building for the Museo Civico of Genoa, an Institution which, under the directorship of the Marquis G. Doria, has, as is well known to all naturalists, carried on splendid work in zoology for many years. We are sure that no better object could be selected for the appropriation of this munificent donation.

MR. G. W. LICHTENTHALER, who died lately at San Francisco, bequeathed to the Illinois Wesleyan University at Bloomington—where he had lived during most of his life—his very valuable natural history collection. It includes from 6000 to 8000 species of shells, 1000 species of marine algæ, and 500 species of ferns, besides thousands of duplicates. Mr. Lichtenthaler also bequeathed 500 dollars to put the collection in suitable shape for preservation.

IN connexion with the International Congress of Medicine and Hygiene, to be held in Rome next September, there will be an exhibition opened (from September 15 to October 15) for apparatus, plans, materials, models, &c., relating to the following: Research in biology, therapeutics and hygiene, medical practice, improvement of the soil, sanitation and hygienic service of towns, hygiene of the interior of public and private buildings, individual hygiene, the health of workpeople, hydrology and balneo-therapeutics, &c. Diplomas and medals will be awarded. For information on the subject application is to be made to the President, Prof. L. Pagliani, Minister of the Interior, Rome.

A NEW scientific society has been organised in Washington, called "The Geological Society of Washington." There are already more than a hundred members. The object of the society is the presentation of short notes on work in progress rather than the reading of elaborate papers. At the first meeting Major J. W. Powell, director of the U.S. Geological Survey, presided, and papers were read by Mr. H. W. Turner, on the structure of the gold belt of the Sierra Nevada, and by Mr. S. F. Emmons on the geological distribution of ore deposits in the United States.

THE disturbed weather conditions referred to in our last issue resulted in a few thunder showers only, more particularly in the southern districts, accompanied by slight rain at some stations. With these exceptions and some local fogs, brilliant weather has been experienced throughout the whole of the United Kingdom. The temperature in the southern and midland districts has been much above the average; a considerable increase set in on the 17th inst., the maximum in London reaching 70°, and since that time some remarkably high readings have been recorded. On the 20th the thermometer over the inland counties ranged from 80° to 84°, while at Yarmouth it read 30° lower, and for several days the difference between these neighbouring districts has been very considerable. In the night of the 22nd a sharp thunderstorm occurred over South Devonshire, accompanied by a local rainfall amounting to nearly three-quarters of an inch, and another storm, with slight rain, occurred at Holyhead in the night of Monday, 24th; but in the early part of the present week the conditions were anti-cyclonic over a great part of the country, and the weather was very dry. The *Weekly Weather Report* of the 22nd instant states that rainfall was upon the whole less than the mean in all the wheat-producing districts and in the south-west of England, while in Ireland and the west of Scotland there was a slight excess. Bright sunshine was less prevalent than for some weeks past; the percentage of possible duration ranged from 24 in the east of Scotland to 58 in the south of England.

THE meteorological authorities in the United States are doing their utmost to utilise weather forecasts by adopting various means for their wide and rapid dissemination. The *American Meteorological Journal* for April contains accounts of two methods recently inaugurated in New England. From September 12 to October 1, 1892, an electric search light placed on Mount Washington was used for flashing forecast signals over the surrounding country. Reports received from persons in the vicinity show that the plan was quite successful, and the flashes were reported to have been seen at a distance of eighty miles. It is intended to resume this novel method next summer. The local forecast official at Boston sends out three hundred printed copies of forecasts daily by rail. The bulletins are distributed from the trains, and posted immediately on receipt in the various railway stations in neat frames provided for the purpose by the Weather Bureau. In this way the forecasts are brought before the public in as short a time as possible.

PROF. J. MARK BALDWIN, of the University of Toronto, has accepted the Stuart Professorship of Psychology in the Princeton University, and will begin work there in September. *Science* says that a suite of rooms has been set apart in North College for experimental psychology, and that a liberal appropriation has been made for its equipment.

MR. W. DE MORGAN, in accordance with the request of the Egyptian Ministry of Public Instruction, has been making experiments at Cairo with Egyptian clays with a view to determine whether it would be possible to use them for the production of glazed earthenware. A correspondent of the *Times* at Cairo says that after about eight weeks' work Mr. de Morgan considers that, whilst the production of porcelain and white earthenware is quite out of the question, there exist abundant materials for other descriptions of pottery, especially white majolica, similar to delft or della Robbia ware. But the cost of fuel is a stumbling-block. Mr. de Morgan, says the correspondent, considers that nothing can exceed the skill of the native throwers, who, with the most simple contrivances, produce far better results than the European workmen with elaborate apparatus.

IN his report for 1892 Dr. Trimen, the director of the Royal Botanic Gardens, Ceylon refers to the fact that of every 100 lbs. of tea consumed in England during the year 84 lbs. were of British growth, viz. 53 in India and 31 in Ceylon, only 16 lbs. being the produce of China. There was an increase of nearly 2,000,000 lbs. in the direct export of Ceylon tea to Australia, viz. 5,166,154 lbs. against 3,210,598 lbs. in 1891; and Dr. Trimen thinks that the costly advertisement at the forthcoming Exhibition in Chicago may reasonably be expected to lead to a large sale in the future in America. Ceylon, he says, urgently needs this; for while there is no reason to fear any drawback to continued success as far as cultivation and manufacture are concerned, there is a real danger of over-production; and its consideration as a possibility, by no means remote, induces him earnestly to recommend those concerned to devote some portions of their land to other cultivations. In the low-country especially much caution should be exercised in opening further land in tea estates. One result of the enormous development of the tea industry in the island is unfortunate. The industry so overshadows all other cultivations that there is now little room for trial or experiment with smaller products on estates, and not much stimulus to investigate them in the Botanic Gardens.

A COMMITTEE called the School Gradation Committee is at present being formed, the object of which, according to the

Times, is to promote the systematic and consecutive gradation of schools and universities, and to supplement the valuable work of recent years in respect of technical instruction by an effort to bring all effective schools and colleges, whether special-ised or not, within a comprehensive national scheme. It is thought that this "may be most economically done, with the *minimum* of interference, centralisation, and narrowing uni-formity, by the recognition and encouragement of existing effective schools, and by using available resources under local control mainly to facilitate the ascent of pupils from lower to higher grades." Among the members of the committee are Sir H. Roscoe, Sir P. Magnus, Prof. R. C. Jebb, Prof. Max Müller, and Prof. H. Sidgwick.

To determine the light refraction of liquid oxygen, Herren Olszewski, and Witkowski (Cracow Academy) have lately made use of total reflection. The liquid was held in a metallic case having windows, and a number of protective envelopes. Into it dipped a double plate formed of two plane-glass plates, with an air layer of 0·006 mm. between, which could be turned from without through a given angle. Monochromatic light was introduced, and the refraction of the liquid determined by means of the bright interference-fringes observed with the netting of the telescope at the borders of the field of total reflection. The relative index of refraction was found to be 1·2232, and the absolute coefficient 1·2235 (Dewar and Liveing, with the prism method, obtained 1·2236). The same authors sought also to determine light-absorption, using for the liquid a pro-tected tube closed below with a glass plate, while another tube with terminal glass plates, dipped in the liquid above, and could be screwed up or down. A ray of light was sent through from below, and passing through various thicknesses of liquid (according to the position of the inner tube) was reflected in a spectral photometer, and compared with a direct ray. For the spectral region of most intense absorption of the green yellow (between $\lambda = 577$ and $\lambda = 570$), values between 84 and 89 per cent. were obtained for the light passing through 1 mm. thick-ness of oxygen; for the red absorption band 88.

THE question of the purity of ice consumed for alimentary purposes in Paris has been lately before the Conseil de Salubrité de la Seine (*Rev. Sci.*). This ice is of two sorts, manu-factured and collected. The production of artificial ice is about 27,000 tons a year, and of the "crop" of natural ice, the lac Daumesnil at Vincennes yields about one-half (12,000 to 15,000 tons a year). The price of the manufactured ice is eighteen to twenty francs a ton; that of the collected ice three to four francs. The demand in Paris is not wholly met from those two sources; and there is some ice imported from Sweden and Norway, which is, naturally, dearer than the ice from lakes, &c., in France. Now the lake Daumesnil just referred to is polluted on the one hand by the entrance of a sewer, and on the other by an artificial stream from the plateau of Gravelle; this stream traverses the Bois de Vincennes, and in the fine season receives all sorts of impurities from its banks. It is a question, therefore, of interdicting the collection of ice from this lake. The sewer it appears, might be suppressed, but the Administration cannot touch the stream. It is proposed to limit the use of ice from sources like this lake to applications in which the ice is not brought into direct contact with the liquids or solids to be cooled, and that when such contact takes place (as in cooling drinks) artificial ice alone should be used, got exclusively from spring water, or river water sterilised by heat.

THE Agricultural Department of New South Wales has been making a series of interesting and useful inquiries as to the plants most visited by bees in the various districts of the colony. Some of the results are set forth in the February number of the Depart-ment's *Gazette*. It has been clearly proved that the flora of Australia includes honey-producing trees, shrubs, and plants of a high standard of excellence; the honey produced by bees in the near neighbourhood of the forest being of the finest quality, and having few (if any) faults. While a gum-tree is in bloom the bee will pass over the most tempting plant in a garden and wing its way to the borders of the bush; but, on the other hand, a field of maize in tassel is a source of the greatest pleasure to the busy little workers, who swarm in countless numbers, collect-ing the pollen so necessary for their wants. The plants which next seem to have the greatest attraction are the fruit-trees, familiarly called summer fruits. Clover (both white and red) yields a large quantity of first-rate honey, and bees kept at places where clover grows never fail to visit the modest flowers of the plant; dandelion, also, is a valuable honey-yielding flower, and is noted in all districts from Albury to Tenterfield. As to the size and colour of the flowers most affected by the bees, much diversity of opinion exists among apiarists, and in the face of the very conflicting replies, the *Gazette* thinks it would be vain to try to determine what coloured flowers are most attractive.

IT is not, perhaps, generally known that the largest wine-growing district in Germany is Alsace-Lorraine. According to a report forwarded to his Government by the French consular agent at Frankfort, while the Wiesbaden regency has only 7,300 acres planted with vines which in 1890 yielded 1,644,040 gallons, the Coblenz regency 18,950 acres, giving 3,755,220 gallons, that of Trèves 8,980 acres, giving 1,832,400 gallons, Alsace-Lorraine alone contains 75,640 acres, the production of which in 1890 was 16,999,000 gallons (6,429,740 gallons in 1891), a production which is chiefly consumed in the country itself. According to the same authority (whose report is sum-marised in the current number of the Board of Trade Journal) the average annual production of wine in the whole world during the five years from 1886 to 1890 is estimated at 2,811,600,000 gallons. In this production Italy figures for 690,008,000 gallons, Spain for 657,250,000 gallons, and France for 606,562,000 gallons; that is to say these three countries supply two-thirds of the total quantity produced. Germany, with an average annual production of 51,705,610 gallons, only occupies the tenth place among wine-growing countries. The value of some of her wines partly compensates her, however, for the relatively small quantity of her annual crop.

THE Imperia Forest School at Dehra Dun seems to be exer-cising a remarkably wholesome influence on the native students who attend its classes. Addressing the students at the recent annual distribution of certificates and prizes, Sir E. C. Buck, secretary to the Government of India in the Revenue and Agricultural Department, said that the school had been a signal success in the widest sense. The student who passed through a technical school was usually fitted only for the technical profession which he was taught at the technical school. But the Dehra School teaching was of such a broad and useful character that he believed its students, that is, the students who passed out of it success-fully, would be more fit for any kind of work requiring originality and practical treatment than the students of any school or college in India. It was the only important educational institution in India in which the student was taught more in the field and in the museum than in the lecture room; in fact in which he was taught how to observe, and how to draw conclusions from obser-vation. The consequence had been that the only signal instances which had, to his knowledge, occurred of original research leading to position and useful results being accomplished by natives of India, had been those in which such results had been produced by ex-students of the Dehra School. Only recently the Government of India had been obliged to close apprenticeships attached to the Geological Department, because natives of India

could not be found qualified for original research. It was not that natives of India had not in them the necessary qualifications; it was that the power lay undeveloped in them, and had not been brought out by a training in habits of observation.

MESSRS. SWAN SONNENSCHEIN and Co. have in the press and will shortly publish a work by Dr. Edward Berdoe, entitled "The Healing Art," a popular history of the origin and growth of medicine in all ages and countries.

AT a recent meeting of the Société Française de Physique M. Janet gave an account of his experiments on electric oscillations of medium frequency (about 10,000 per sec.). The arrangement he employs is as follows:—A battery of accumulators furnishes a current which passes through a high resistance CD and a low resistance AB placed in series. The ends of AB are joined to the plates of a condenser and also to the extremities of a circuit AHB. The latter consists of a coil of self-induction L and resistance $\frac{R}{2}$ joined in series with an equal non-inductive resistance. The quantities RL and the capacity of the condenser are so chosen that when the circuit is broken at AB oscillations are set up in the condenser circuit. By means of an interruptor, closely resembling that used by Mouton in his work on the discharge of a condenser, the differences of potential e_1 and e_2 at the extremities of the inductive and non-inductive resistances are determined at different times after the breaking of the primary circuit, and the values plotted on a curve as functions of the interval after the break. If i is the current in the circuit AHB at any instant then the first curve gives the value of $\frac{R}{2}i + L\frac{di}{dt}$, and the second that of $\frac{R}{2}i$; so that $L\frac{di}{dt}$ is equal to the difference of the ordinates. The value of $\frac{R}{2}\frac{di}{dt}$ can be obtained from the second curve, so that if the self-induction is constant during an oscillation the ratio of these two quantities will be constant. This is found to be so, the value of L deduced from the curves being constant and also independent of the capacity of the condenser and of the electromotive force employed in the primary circuit. The author has also obtained from his observations the value at each instant of the difference of potential V between the plates of the condenser (a mica one) and of the charge Q, and he finds that the quotient $\frac{Q}{V}$, representing the capacity of the condenser, is greater for decreasing than for increasing values of V. The shape of the curves obtained recall those Ewing has found in the case of the magnetisation of iron, and indicate a kind of hysteresis or viscosity in the dielectric.

THE problem of obtaining a well-defined and trustworthy standard for the intensity of a source of light can hardly be said to be completely solved. Violle proposed as a unit the amount of light radiated by one square centimetre of molten platinum at the moment of solidification. But in order to keep the platinum absolutely pure, and its surface clean and smooth, it would be necessary to melt large quantities of the metal in an electric furnace. Siemens proposed platinum foil at the instant of melting, but a series of 500 meltings gave deviations of 10 per cent. in spite of the greatest precautions, mainly on account of the tearing of the foil on melting. According to a report recently presented to the Reichstag, the physicists of the Imperial Physico-Technical Institute at Berlin have been endeavouring to make Siemens' unit available for practical purposes by fixing the temperature of the platinum in some manner independent of its melting point. It was found that at any given temperature the ratio of the total radiation to that transmitted by a layer of water of a certain thickness was constant within 2 per cent. for plates of platinum of different thicknesses and from different sources. To measure the amounts of radiation a very delicate bolometer was constructed. A piece of platinum foil was welded on to a piece of silver foil of ten times its thickness, after which the combination was rolled between copper rollers down to a thickness of $\frac{1}{100}$ mm. It was then cut in a dividing machine so as to form a long continuous strip of 1 mm. breadth within a small area. Four such strips were mounted in a frame, and freed from silver by etching with acid, thus leaving strips $\frac{1}{1000}$ mm. thick. When tested, the bolometer was found to be extremely satisfactory. The Institute is at present engaged on determining the absorptive action of water and of the quartz vessel containing it. Further important questions are those regarding the effect of impurities in the platinum and the kind and duration of incandescence, questions which must be answered before the method can be regarded as thoroughly practical.

AMIDOPHOSPHORIC ACID, $PO.NH_2.(OH)_2$, the primary amine of orthophosphoric acid, has been isolated by Mr. H. N. Stokes, and its properties and those of several well-crystallising salts are described by him in the March number of the *American Chemical Journal*. It has hitherto been found impossible to obtain this substance owing to the extreme difficulty of regulating the decomposition by water or acids of the products obtained by the action of ammonia on pentachloride or oxychloride of phosphorus. It has now been obtained, however, by employing, instead of the two latter compounds, the ethers of phosphoric acid. The most advantageous method is to dissolve the chloride of diphenylphosphoric acid, $PO.Cl(OC_6H_5)_2$, in alcohol and to react upon it with alcoholic ammonia, when a beautifully crystalline substance, diphenylamidophosphate, $PO.NH_2.(OC_6H_5)_2$, is at once formed. This diphenyl ether of amidophosphoric acid yields an alkaline salt of amidophosphoric acid upon saponification with caustic potash or soda; upon converting this into the lead salt, decomposing the latter with sulphuretted hydrogen, and precipitating with alcohol, the free acid is obtained in the form of fine microscopic crystals. In the actual preparation it is not necessary to first isolate the chloride of diphenylphosphoric acid. It is only necessary to boil one molecular equivalent of phosphorus oxychloride with two molecular equivalents of phenol in a flask attached to a reflux condenser until no further evolution of hydrochloric acid occurs: the product contains, along with other derivatives, the chloro-diphenyl ether required. The liquid only requires to be diluted with alcohol, when the alcoholic ammonia may be directly added and the crystals of the amido diphenyl ether precipitated. Diphenylamidophosphate is a comparatively stable substance melting at 148° and resolidifying to a mass of crystals. The crystals are readily converted into acid potassium or sodium amido phosphate by means of a concentrated solution of caustic potash or soda; the reaction is very energetic and is complete in ten minutes. Upon acidification with ice-cold acetic acid and addition of alcohol, the acid salt is precipitated. Acid potassium amidophosphate, $PO\begin{cases}NH_2\\OK\\OH\end{cases}$, crystallises in six-rayed stars or rhombohedra; the neutral salt is extremely soluble in water and is very difficult to obtain crystallised. The acid sodium salt usually forms small hexagonal crystals, and the neutral sodium salt also crystallises well and, unlike the potassium salt, is not deliquescent. The lead salt is obtained in the form of a precipitate, consisting of groups of radiating plates, upon adding a solution of lead acetate to a solution of the acid potassium salt. In order to obtain the free acid from it, the crystals are suspended in iced water and a current of sulphuretted hydrogen allowed to bubble through. The filtrate from the sulphide of lead may then be allowed to fall directly into alcohol when the crystals of amidophosphoric acid are at once deposited.

Amidophosphoric acid crystallises in tabular or short prismatic crystals which are insoluble in alcohol, but readily soluble in water, to which they impart a sweetish taste. The solution is readily distinguished from phosphoric acid inasmuch as it yields no precipitate with silver nitrate. It evolves no ammonia upon treatment with caustic alkalies, but merely forms the salt of the alkali metal. The solution slowly decomposes into ammonium phosphate. The solutions of the acid and neutral salts of the alkaline metals yield many corresponding acid and neutral amidophosphates of other metals by double decomposition with soluble salts of those metals.

Notes from the Marine Biological Station, Plymouth :—Last week's captures include *Phoronis hippocrepia*, the Actinian *Corynactis viridis*, and the Foraminiferan *Haliphysema*. In the floating fauna the Cœlenterate element remains unchanged ; the larvæ of the Nemertine *Cephalothrix* have made their first appearance for the year ; the number of Polychæte larvæ and of Cirrhipede *Nauplii* has become considerably smaller ; the later stages of various Decapod Crustacea (*Megalopa*, *Mysis*-stages) have appreciably increased in numbers ; and minute young *Oikopleuræ* now occur in considerable quantity. The "gelatinous alga" and *Rhizoselenia* are extremely abundant. The Hydroid *Tubularia bellis*, the Gastropod *Nassa reticulata*, and the Decapod Crustacea *Pagurus lævis*, *Galathea squamifera*, *Porcellana platycheles* and *Pilumnus hirtellus* are now breeding.

The additions to the Zoological Society's Gardens during the past week include an Orang-Outang (*Simia satyrus*, ♂) from Borneo, presented by Mr. Thomas Workman ; a Spotted Ichneumon (*Herpestes nepalensis*) from India, presented by Lady Blake ; a Raven (*Corvus corax*) British, presented by Lady Rose ; a Peregrine Falcon (*Falco peregrinus*) British, presented by the Old Hawking Club ; a Greek Tortoise (*Testudo græca*) European, presented by Mrs. Alcock ; a Martineta Tinamou (*Calodromas elegans*) from Argentina, three Spotted-sided Finches (*Amadina lathami*) from Australia, purchased ; a Panama Amazon (*Chrysotis panamensis*) from Panama, received in exchange ; six Indian Wild Swine (*Sus cristatus*), four Barbary Mice (*Mus barbarus*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

Large Telescopes.—Much has been written during the last few months with reference to the usefulness or non-usefulness of large telescopes. That the verdict is given in favour of the former is not at all surprising, for are we not far away from the limit, if there be one, beyond which larger instruments will be available? Dr. Common has many times pointed out the practicability of constructing large reflectors (his five-foot being a good example of the type of instrument he could enlarge), while the Lick instrument, the work of the Clarks, is really only a beginning of what will be done in large telescope building. For refractors it has many times been urged that the increase in size of lenses involves such a thickness that much light is thereby lost by absorption. M. Alvan G. Clark, with reference to this particular point, says a few words in *Astronomy and Astrophysics* for April, in which he points out that such is not the case. Greater aperture means greater light-grasping power, and as it is quite unnecessary to considerably increase the thickness of the lens, the former predominates over the latter. With the forty-inch discs, he says, only a combined thickness of four inches is required, and with lenses of an object-glass of even six feet aperture a combined thickness of only six inches would be necessary. It is pleasing to hear through him that a steady improvement is being made in manufacture of glass, and that the present discs are *infinitely* superior to the early ones, and "who knows," as Mr. Clark says, "how soon still more transparent glass may be at hand."

Spectrum of β Lyræ.—The extreme interest that lies in this variable, especially for spectroscopists, makes it a subject of keen research, and the important observations made by Prof. Keeler with the great Lick refractor, and contributed to the number of *Astronomy and Astrophysics* for April, will be the more eagerly read. The observations were undertaken with the intention of connecting possible changes in the spectrum of the star with its period of light variability. After plotting a number of observations on the light curve of the star, the recorded appearances of the spectrum "were in some degree contradictory," although certain results were obtained, but they were left incomplete, owing to Prof. Keeler's withdrawal from the observatory. The results may be briefly stated as follows :—

(1) Bright hydrogen lines C and F, bright D_3 line and dark D lines are always visible with the Lick refractor. Certain fainter bright lines are absent only at principal minimum.

(2) Light variations due to changes in brightness of continuous spectrum.

(3) Bright lines brightest when continuous spectrum brightest.

(4) Bright lines broad and diffuse, particularly when star at maximum. D lines very hazy, so that components are hardly distinguishable.

(5) No really remarkable changes in the appearance of the spectrum took place during greater part of period. Observations show no relation between spectral changes and secondary minimum of the star.

(6) Most remarkable changes at principal minimum. "The bright lines became dimmer and perhaps sharper. The fainter bright lines disappear. The D lines become darker. Strong absorption lines appear on the more refrangible side of certain bright lines in the green, the separation of the dark and bright lines being at least five-tenth-metres. Other bright lines are perhaps similarly affected. A narrow dark line appears above the D_3 line at the same time. Shortly before the first maximum is reached the dark lines disappear."

Prof. Keeler adds that the method of observation he adopted was only capable of allowing him to observe a "part of a much more complex series of changes" which no doubt takes place.

Société Astronomique de France.—In the *Bulletin* of this society for 1892, the sixth year since its foundation, several articles of importance will be found to be scattered throughout its numerous pages. Of these we may refer our readers to some selenographic studies by MM. Gaudiberi, Flammarion, and Antoniadi, examination of recent studies of Jupiter by M. Flammarion, and M. Edouard Foulséré's graphical method of determining the co-ordinates of solar spots. The valuable observations made by M. E.-L. Trouvelot on the planets Venus and Mercury, a full account of which has been given in these columns (Nature, vol. xlvi. p. 468), will also be found here, together with a discourse by M. F. Tisserand on the movement of the moon, with reference to ancient eclipses. Among other communications M. Schmoll gives a summary, with tables, of the solar spots observed during the year 1891, M. Guillaume describes his observations on the surface and rings of Saturn, and MM. Quenisset and Trouvelot contribute their observations on planets and remarkable solar protuberances respectively. A simple method of determining the positions of solar spots, and of measuring their displacements, is treated by Dr. Huette, while M. Bruguière gives a most interesting account of M. Lippmann's work on photography in colours, and M. Pluvinel on the coming (now past) eclipse of the sun.

Wolsingham Circular, No. 34.—With reference to the contents of the Wolsingham Circular, which we recently gave, Dr. Kreutz, in *Astronomische Nachrichten*, says :—"The first star, Esp.-Birm 180, is certainly given by Chandler as (2258). Aurigæ in his list of probable variable stars A. J. 216 ; see also *Astronomische Nachrichten*, 2764, p. 63, No. 2. The second star is evidently identical with B.D. + 57°·727 = A. G. Hels. 3032. Position for 1900 : 3h. 23m. 23s., + 58° 9′·0. The original magnitudes of the Hels. zones are : 9·1m (February 15, 1872), and 9·0m. (February 15, 1873).

Astronomical Journal Prizes.—The judges appointed by the editor of the *Astronomical Journal* say a few words in the current number (No. 293) with reference to some general considerations connected with the presenting or withholding of the awards. For comet observations, allowance for optical qualities of telescopes will to a certain extent be made ; relative freedom from systematic peculiarities of observation will be regarded "as a mark of excellence. Even more important than the nominal or apparent precision in other respects." For individual precision of observations, freedom from large or abnormal errors

would be of the first importance. In orbit computation the judges will regard with special attention care exercised in revision of published observation, ingenuity displayed in searching out and evaluating systematic errors, completeness and soundness of discussion, ability shown in indicating probable limits of uncertainty in adopted elements, &c. With regard to variable stars, enough has already been said, but the judges remark that definite reductions cannot of course be expected, as from the nature of the case many years must elapse.

GEOGRAPHICAL NOTES.

THE Hon. G. N. Curzon, M.P., read a paper on his recent journey in Indo-China at the meeting of the Royal Geographical Society on Monday. The whole region, he pointed out, is dominated by its great rivers, and may be divided into the mountain district of the north cleft by vast gorges, and the low plains of the south mainly composed of alluvial deposits, where the coast lands are steadily encroaching on the sea. In the seventh century Tongking, now 60 miles inland, was on the coast. A very remarkable feature which gives to parts of the coast a beauty comparable with that of the Inland Sea of Japan is a broken belt of limestone cut into curious flat-topped sections of all sizes, and perforated by the sea or rivers with many fantastic caverns and tunnels. The masses of caverned rock rise to a height of from 50 to 500 feet, and are best seen in the Bay of Along in Tongking. In Annam Mr. Curzon travelled to Hué by the "Mandarin's Road," a track which is carried over several cols by some skilful engineering in the form of rock staircases. Throughout Annam the traveller is much confused by the number of names applied indiscriminately to each village, and the maps hitherto constructed by the French officials are far from satisfactory. The people of Annam have the submissiveness without the nerveless apathy of the Hindu, and as craftsmen they are industrious and artistic. Coal is abundant, some seams being more than 180 feet thick at Haton, on the Bay of Along. Hué is a city of great interest, being beautifully situated and near a number of magnificent ancient tombs. Cambodia or Cambogia, as Mr. Curzon prefers to spell the name, is of interest, mainly on account of its ruins, the number and character of which make a long stay desirable, if the traveller would do justice to his opportunities.

THE newly published report of the Bengal census reveals the interesting fact that there is a steady transference of population from the most densely to the more thinly peopled parts of the province, the former prejudice against leaving the native village having apparently vanished. Mohammedanism is increasing rapidly in Bengal, and the custom of widow marriage amongst Hindus has become common. These facts are significant of progress.

THE supremacy of the great ports of Europe as entrepôts for the trade of the world is rapidly becoming a thing of the past. Two recent instances of independent action on the part of the colonies are of more than local importance. One is the establishment of a line of steamers trading direct from New York to Cape Town, another the commencement of a regular service of fast steamers from Vancouver to Sydney, N.S.W.

A COMMUNICATION was lately made to the Paris Geographical Society on the strength of a statement in a Russian newspaper, describing a curious mountain group in Podolia. This is said to rise abruptly from the plain with a grandly rugged crest composed of a broken circular rim surrounding a crater-like depression. The whole mass is composed of limestone, in which fossil corals abound, and the inference drawn is that this is, in fact, a full-sized fossil tertiary atoll. The name of the mountain is given as Miodoborski, but it is called Toltra by the natives.

AT a general meeting of the Royal Geographical Society called by the requisition of a few Fellows who objected to the action of the Council in the manner of admitting women to the Fellowship of the Society, it was proposed to frame a bye-law restricting the privileges of lady Fellows, and rendering them incapable of serving on the Council or in any office in the Society. The question whether ladies should be admitted at all was voted upon after a somewhat heated discussion, and it was decided by 147 to 105 that women should not be admitted as Fellows of the Society. This decision was entirely unforeseen; it is a retrograde step which, we feel sure, will be disapproved and regretted by the majority of the Society.

THE Royal Medals of the Royal Geographical Society have been awarded to Mr. F. C. Selous for his travels in Africa, and to Mr. W. W. Rockhill for his journeys in Tibet. The Gill Memorial was awarded to Mr. H. C. Forbes, and the Cuthbert Peek Grant to Mr. Charles Hose for his travels in Sarawak. Major Powell, Washington, Prof. Ratzel, Leipzig, and M. Vivien de St. Martin, Paris, were elected honorary corresponding members of the society.

INSTITUTION OF MECHANICAL ENGINEERS.

ON the evenings of Thursday and Friday last week, April 20 and 21, an ordinary general meeting of the Institution of Mechanical Engineers was held in the theatre of the Institution of Civil Engineers, by permission of the Council of the latter body. There were three papers on the Agenda, but only two were read, namely, Mr. Dean's paper on copper plates for locomotives, and the second report of the Alloys Research Committee, the author of which was Prof. W. C. Roberts-Austen, C.B., F.R.S. Our readers will remember that the first report of the Alloys Research Committee was read, and discussed at the October meeting of 1891, and an abstract of it appeared on page 22 of our 45th volume. A large part of the first report was taken up by the consideration of the effect of various alloys on gold, and it will be remembered that the author was somewhat sharply criticised for the course he had taken in framing his report, gold being a metal not used by engineers, at least for constructive purposes. This second report carries the matter further, and it is possible now to appreciate Prof. Roberts-Austen's reasons for taking the course he did. In opening the subject he referred again to the "periodic law" of Newland and Mendeleeff, and upon it he based a large part of his reasoning in the first report. The researches of Raoult Van't Hoff, and Arrhenius, led to the view that the molecules of small quantities of elements, distributed through a mass of a solvent, retain their individuality. The work of Heycock and Neville (and also the experiments described in the author's previous report) point to the conclusion that the added elements may retain their freedom when they are present in much larger quantities than 0·2 per cent., which is the amount of added matter the Committee usually dealt with in their researches. The point raised was whether the added element does, or does not, remain free in the mass of the solvent, and as the author pointed out, it is a vital one in limiting the scope of the inquiry.

If the added element enters into combination with the solvent its individuality will be changed, and it might be that the mechanical properties of the metallic mass would mainly depend on the degree of fusibility of the compound formed. If the concentration of the solution is such that a fraction of the dissolved body alone remains isolated, the influence of the volume of the added elements, will evidently be disturbed, as this influence is supposed to be exerted only by a single constituent of the mixture, whilst the mechanical properties of a solidified mixture are functions of both constituents, in the favourable circumstances where the solvent is not started by the added element, and where the law of atomic volumes is applicable. A metal is seldom homogeneous and is more often formed of rounded polyhedral grains, and the cohesion in the interior of a grain differs from the adherence between the neighbouring grains. The law of atomic volumes cannot apply, the report pointed out, to the adherence of the grains, that being regulated by other causes, such as the rate of cooling and pressure, and whether a compound be formed, which solders the grains together. Arguing from these facts, the author pointed out that an attempt to prove the nature of the influence of atomic volumes by mechanical tests only led to anomalies, and more or less grave irregularities being encountered. The investigation was not, however, limited to mechanical tests, independently of which it had been shown that the influence of impurity on the molecular transformation in iron, studied by Osmond, may be shown in several ways. Transformation may be assisted by the presence of impurity, the temperature at which they occur may be altered, or the molecular changes may even be entirely prevented by the presence of elements which behave in strict accordance with the law of atomic volumes. The author referred to the remarkable series of experiments recently made by E. Warburg and F. Tegetmeier, which would seem to demonstrate the possibility of producing eventually a degree of porosity in vitreous bodies, which will admit the passage of elements having comparatively small atomic volumes, while other elements, having larger atomic volumes, are strained off, thus occasioning

a mechanical sifting of the elements. In making these experiments, a cup-like receptacle was used, which had a vertical partition of sheet glass placed in it, so that the cup was divided into two parts by the glass. Sodium amalgam was placed on one side and pure mercury on the other; the whole was then heated to a temperature of 200° C., at which the glass became slightly conducting. By the aid of a battery, the sodium atoms of the sodium silicate were set in motion, and after 30 hours it was found that a considerable quantity of sodium, amounting to 0·05 gramme, had passed into the mercury which was originally pure. A corresponding amount of sodium had been lost by the amalgam, but the glass had exactly preserved its original weight and clearness. The glass was partly composed of neutral molecules of sodium silicate, together with free molecules both of sodium (base) and of the acid, and of the free sodium capable of being transported under the influence of the electric current. When Tegetmeier replaced the sodium amalgam by lithium amalgam and repeated the experiment, the sodium of the glass passed as before into the originally pure mercury, and the glass became opaque on the side touching the lithium amalgam; but after a time the opacity extended right through the thickness of the glass, and the metallic lithium began to accumulate in the previously pure mercury. It is not possible thus to chase out all the sodium present in the glass; but the free sodium atoms are replaced by those of lithium. Analysis showed that the glass originally contained 2·4 per cent. of potassium and 13·1 per cent. of sodium; but after the experiment, while retaining the same percentage of potassium, it had only 4·3 per cent. of lithium, and only 5·3 per cent. of sodium. The glass in which lithium had thus replaced part of the sodium was very tender, opaque, and friable. The conclusion to be drawn is that the atoms of lithium, having an atomic weight of 7, and an atomic volume of 15·98, can pass along the tracks, or molecular galleries left in the glass by the sodium atoms, the atomic weight and volume of which are 23 and 16·04 respectively. When a metal of superior atomic weight and volume to sodium was substituted for the lithium—such as potassium, with atomic weight 39 and atomic volume 24—it was found not possible to chase out the sodium, the new atoms being too big to pass along through the spaces where the sodium had been. We are thus confronted with a molecular porosity which can in a sense be gauged; and the mechanical influence of the volume of the atom is made evident. Proceeding to the details of the experiments made by the committee, the influence of impurities on copper was next referred to. The question was raised whether normal copper can be made to assume an allotropic state, analogous to that in which there is reason to believe iron can exist, and if so are the properties of normal and of allotropic copper as widely different from each other as those of the distinct varieties of certain well-known non-metallic elements. The point is one of considerable interest, and Prof. Roberts-Austen seems to have little doubt that copper can be prepared by electrolytic deposition, in an allotropic state, in which the density of the metal is from 80 to 82 as compared with 8·92, which is that of normal copper. The effect of mechanical and thermal treatment upon copper was then referred to, and some interesting figures were given, showing how different may be the properties of a metal chemically pure; for instance, rods of very pure electrolytic copper, all the same sample, but variously treated, broke under stresses varying between 8·219 tons and 18,750 tons to the square inch; the former being the tensile strength of cast rods, and the latter of cast rods worked and not annealed; whilst cast rods carefully worked, and annealed gave a tensile strength of 18·259 per square inch. The experiments show a difficulty in determining a standard tenacity for copper.

The effects of arsenic, bismuth, and nickel upon copper afforded one of the most interesting parts of the investigation, and from the engineer's point of view an extremely important section of the series of experiments. It has been too often accepted as a matter of fact that pure copper is the best that can be used for engineering purposes, and specifications are generally framed to this effect. The Research Committee, however, show that the metal may be, and frequently is, as a matter of practical fact, too pure for the purpose; thus, it has been found that a very fair percentage of arsenic improves the copper used in fire boxes of locomotives. It is well known that of old these parts of the boiler lasted for a much longer period of time than they do in the present day. In fact, as Mr. Tomlinson, an old railway engineer, said in the discussion, they used to expect to get half a million miles of running out of a copper fire box, whereas about half that distance is all that is obtained in the present day. This he attributes to the effect of electrical matters upon engineering practice. The electricians insist on their copper being absolutely pure, and that has raised the standard, so that now the copper smelters get all the impurities out of the metal, whereas in old times a considerable percentage of alloy, especially arsenic, was present. Antimony appears to behave like arsenic, and when present in proper proportion greatly strengthens the copper. Bismuth, on the other hand, renders copper singularly weak. With 0·1 per cent. of bismuth a sample of copper was too brittle to work, and had at the ordinary temperature a tenacity of 18,000 tons to the square inch; but at a higher temperature the fall in tenacity was very rapid, and there was practically no elongation. The prejudicial effects of bismuth did not seem to disappear, even though but a trace were present. In one test of a singularly pure copper, containing only 0·002 per cent. of bismuth, although the metal was strong and worked well, the elongation was very small. The variation in the effect of arsenic and antimony on the one hand, and of bismuth on the other, is of considerable interest, for according to the classification of Mendeleeff, arsenic, antimony, and bismuth all belong to the same family, of which nitrogen is a type. The atomic volume of bismuth—20·9—is, however, higher than that of arsenic—13·2, or of antimony—17·9, and therefore, according to the principle laid down by Prof. Roberts-Austen, bismuth ought to diminish the tenacity of copper, of which the atomic volume is only 7·1. But in accordance with this reasoning the influence of arsenic and antimony should be exerted in the same direction, even though in a less degree. The author has turned his attention to this matter, and has already been conducting a series of experiments which have extended over nearly twelve months. The investigations are, we believe, not yet complete, but the results will be given subsequently. A diagram was, however, exhibited at the meeting, in which curves were shown, illustrating the behaviour of various alloys of copper and bismuth during cooling, and the wholly unexpected fact was revealed that the copper passed below the freezing point before it actually became solid. On each curve there was a second or lower point of solidification, which occurred at a constant temperature in all the alloys, and was very close to the melting point of bismuth itself. The existence of this second point was very evident, even when the copper contained only one per cent. of bismuth, and this fact goes far to explain the peculiar action of bismuth on copper. It would appear that whether very poor or very rich in bismuth, the alloy of copper may be a portion of bismuth, containing perhaps a little copper, always remains fluid until the temperature of the mass has fallen to 260° C., which is the point at which bismuth tself solidifies. The presence, Prof. Roberts-Austen stated, of a fluid constituent in an alloy long after the mass itself had become solid, is doubtless the determining cause which enables the metal to assume a highly crystalline, and consequently an intensely brittle structure. So far as he was aware the cause of the peculiar behaviour of bismuth could not have been revealed by any other method of investigation than the one adopted. In connection with this point, a fact brought forward during the discussion by Mr. Gowland, is of interest. In the course of his metallurgical work at the Japan mint, he had brought before him a large number of bars of silver for the purpose of coining, but they were so brittle that it was impossible to work them at all. On investigation he found that there was an appreciable quantity of bismuth in the silver. The structure was coarsely crystalline, and though the whole mass was so hard and brittle, the crystals themselves were very ductile. The conclusion he came to at the time was that the crystals of silver had become separated, as it were, by a film of bismuth. The fact bears out the correctness of Prof. Roberts-Austen's mode of reasoning. Judging from their polished surfaces, the alloys of copper rich in bismuth are to all appearances as coherent as the alloys of copper and tin, which have great strength. The report gives some interesting particulars of the effect of pressure. The passage of iron from one allotropic modification to another is accompanied not only by a change of heat capacity, but also by a change of volume. This matter was referred to in the previous report, but the author gave some further interesting particulars of experiments carried out by compressing a piece of steel in a hydraulic press, in order to obtain recalescence at a lower temperature than would be the case if the

pressure were not applied. In one case a cylindrical piece of steel, 1" long and ⅞" in diameter, was bored through two-thirds of its length by a hole $\frac{1}{16}$" in diameter, in which a thermal junction was placed. The mass was heated to 1000° C., and it was found that without the application of pressure recalescence occurred at 650° C., but when a load of 9 tons per square inch was applied, recalescence occurred at 620° C., and was comparatively feeble. The experiment, it need hardly be said, is one very difficult to make, and could only be done by those having command of special apparatus. Other experiments were carried out, the result showing that the recalescence point is lowered by pressure, but it was found that the lowering was not affected, unless the load was applied at a temperature well above that at which recalescence takes place. Experiments were made with Newton's alloy of bismuth, lead, and tin, the full results of which will be published at some future time. In considering the whole scope of the report, the author said that it might be asked what evidence had been gathered as to the mode of action of added elements, and whether it appeared that the atomic volume of the added element had a dominating influence on the mechanical properties of the mass in which it is hidden? The true action of an added element, the author pointed out, may readily be masked by its action as a deoxidiser. Notwithstanding these difficulties, it is undoubtedly proved that bismuth, potassium, and tellurium, all of which have atomic volumes, greatly lower the tenacity of copper. Arsenic, which has a larger atomic value (13·2) than copper (7·1) confers strength on copper, but it is very certain that the limit of elasticity, and the ductility of a metal are greatly influenced by the presence of an element with large atomic volumes. This fact may be of more molecular significance than the diminution of tenacity, to which, for the sake of simplicity, attention was mainly directed, when the early experiments on gold were made.

In the discussion which followed the reading of the paper a number of speakers took part. The most important contribution was that of Dr. Watson, of the Broughton Copper Company, who brought forward some practical experience to reinforce the deductions of the author. Mr. Arnold, of the Technical Schools, Cambridge, read a very long manuscript, which it would be rash on our part to attempt to abstract, and which we cannot afford the space to give in full. Mr. Hadfield, of Sheffield, questioned the accuracy of the beta form of iron theory promulgated by Osmond and adopted by the author. The point is one of considerable importance, but requires a wide field for its discussion.

On the whole it cannot be doubted that the report is a most valuable contribution to the scientific knowledge at the command of the engineer, and were the attention called to the action of bismuth on copper its sole result, the labours of the committee would not be without warrant.

The summer meeting of the institution will be held this year at Middlesborough on August 1 and three following days.

CONIFERS.[1]

THIS is a bulky volume of nearly 600 pages, and contains a vast amount of information. If the Royal Horticultural Society had published nothing but this since 1891 they would have amply satisfied those who are interested in conifers, and have keenly felt the want of such a book of reference as the one now under notice. Some of the papers published in the report could have been omitted without loss, but on the whole the editors have done their work well. In the preface they say, in sending out this memorial of the Conifer Conference, 1891, "we would draw attention to the fact that it contains far more than a mere verbal report of the conference, Dr. Maxwell T. Masters, F.R.S., and Prof. Carl Hansen, of Copenhagen, having promised at the time to recast their notes more fully. This they have done most kindly, and with infinite labour and research, but not without some little expenditure of time, the final sheets of MS. having only come into our hands in July, and the corrections extending up to September 29.

"The names adopted by Dr. Masters and Prof. Hansen may, of course, be relied upon as representing the latest decisions of botanical science in England and on the continent of Europe respectively, though future research may necessitate some still further slight alterations. However, the hitherto inextricably confused nomenclature of conifers may safely be described as settling down upon the lines adopted in this volume by these two eminent authorities, who, although not yet in absolute agreement, will be found to approach very nearly."

[1] Report of the Conifer Conference, 1891 (issued November, 1892).

The list of conifers and texads, by Dr. Masters, is by far the most important contribution to the nomenclature and synonymy of conifers which has appeared since the publication of Parlatore's monograph in De Candolle's "Prodromus" in 1868; it is much more complete than Beissner's "Handbuch der Coniferen-Benennung," and the more recent "Handbuch der Nadelholzkunde," of the same author. There seems no reason to doubt that Dr. Masters's list will be used and followed by English systematists generally. Dr. Masters, in drawing up the list of genera, follows Bentham and Hooker's "Genera Plantarum" as the standard authority. A few deviations from it have, however, been made in accordance with more recently obtained knowledge. Pseudolarix is accorded generic rank (and not united with Larix, as in the "Genera Plantarum," whose authors had not seen male flowers); Keteleeria too, after a careful study of living material, has been separated from Abies and reinstated as a genus—Dr. Masters's studies having on these points proved the justice and accuracy of Carrière's views. The Chilian Prumnopitys is restored to generic rank, and separated from Podocarpus, with which it was united by Bentham and Hooker.

The Pinetum Danicum of Prof. Carl Hansen is unsatisfactory, and its omission from the report would have been desirable. It is a somewhat ambitious performance, but in bulk is very largely made up of extracts from books and periodicals. Many of the records are certainly useless; for instance, under *Pinus longifolia*, it is stated: "one plant, however, exposed out of doors does not appear to have suffered"; this Indian species is tropical in its requirements, and as it will not grow out of doors even in the south of England, it is in the highest degree improbable that it would, even under the most favourable conditions, exist in the open air in Denmark. A curious mistake occurs on p. 372, where the Viennese botanist, Prof. Günther Beck, Ritter von Mannagetta, figures as Prof. Günther, Knight of Beek von Managetta. On p. 330 Prof. Hansen remarks under Prumnopitys that its wood is much valued by "ebonists." He probably means cabinetmakers (ébénistes). *Tsuga hookeriana* and *T. pattoniana* are kept up as distinct species by Hansen; but Prof. C. S. Sargent, who is familiar with the two forms in their native habitats, has no hesitation in regarding them as specifically identical. Hansen accords generic rank to Biota, Thuyopsis, and Chamæcyparis, the first and second being merged into Thuya, and the third into Cupressus by Dr. Masters. It is rather annoying to find the obsolete geographical expression "New Holland" constantly used by Hansen. New Holland and South-east Victoria are given as the native countries of one species.

The coniferæ of Japan, by H. J. Veitch, is a valuable paper. From it we learn the somewhat startling fact that, in proportion to the area of the country, the flora of Japan contains more coniferous species than that of any other country in the world. Japan boasts of forty-one species and thirteen genera, whereas in the whole of Europe there are but eighteen species and seven genera.

A. D. Webster, "Conifers for Economic Planting." Mr. Webster is a practical forester of wide experience, and he considers that out of all the conifers cultivated in Britain only sixteen can be utilised in an economic sense, or for truly profitable planting. These are the larch, silver fir, Corsican pine, Douglas fir, *Pinus Strobus*, Scotch fir, *Thuya gigantea*, Spruce fir, Austrian pine, *Pinus Pinaster*, *Abies nordmanniana*, *Sequoia sempervirens*, *Cupressus macrocarpa* (or, as Mr. Webster calls it, *C. lambertiana*), *Cedrus atlantica*, *Pinus rigida*, and *Cupressus lawsoniana*. The order in which these names are given represent the relative value of the trees as timber producers. Under each heading Mr. Webster gives valuable data as to rates of growth under different conditions as regards soil, elevation, &c.

In a compact paper of thirteen pages Mr. W. Somerville gives a very good *résumé* of the present state of our knowledge of the quality of coniferous timber as affected by sylvicultural treatment. Mr. Somerville's remarks are sure to be perused with profit by landowners and foresters.

Mr. D. F. Mackenzie, on the timber of exotic conifers: uses and comparative value, contributes much valuable information. Taking the value of Scotch fir timber at 100, the author calculates that of *Cupressus macrocarpa* at 190 and that of *C. lambertiana* at 283; as these two names represent one and

the same species, the widely different results are probably due to the trees furnishing the timber having been grown under different conditions. Mr. Mackenzie mentions a curious fact "observed in the working of the various pine timbers I have named. It was found that the wood of pines having three leaves in a sheath was, as a rule, much harder than those having only two, whilst all those having five leaves in a sheath were uniformly soft, and when dressed had a silky appearance. So general is this characteristic that one could almost at once tell to what class a certain plank of pine timber belonged." These observations we do not remember to have seen previously recorded.

"The Diseases of Conifers." Although in German there is a literature of considerable extent on this subject, the publications in English are few. Prof. Marshall Ward is a very careful and competent observer, and his contribution to the report is of great value both to the man of science and to the practical forester.

Mr. W. F. H. Blandford's insects injurious to conifers is an excellent *résumé* of all that is known up to date of the life-history of the various insect pests, which have been noted as injurious to conifers. How important this subject is may be judged by the destruction wrought by the larvæ of *Liparus monacha* between 1853 and 1868 in East Prussia, Poland, and Russia, where the spruce was killed over an area of 7000 square German miles. A similar instance is that afforded in 1890 in the Bavarian forests by the same destructive insect, the loss caused by this to the revenue being estimated at £40,000. Those, however, who, like the writer of these notes, travelled over the districts affected during the ravages of the larvæ, would realise much more vividly the gravity of the attack than others could from a mere perusal of statistics.

Not the least valuable portions of the report are the statistics of conifers in the British Islands, and the value in the British Islands of introduced conifers, by Mr. Malcolm Dunn. These statistics represent an enormous amount of energy and perseverance on the part of the compiler. The tabulated forms give particulars from a large number of places in the British Islands, and deal with the soil, altitude, age of trees, their height, girth, &c. The list of conifers and largest specimens, also by Mr. Dunn, gives the dimensions of the largest specimens taken from the above-mentioned tables and also the number of returns respecting each species. G. N.

THE EARTHQUAKES IN ZANTE.

LAST week we noted the fact that another disastrous earthquake had occurred in Zante on Monday, April 17, and that it had been followed by various slighter shocks. According to a special correspondent of the *Times* at the town of Zante, the centre of the disturbance seems to have been under the sea about two miles from land. Before the great shock the inhabitants of the district of Vasilikos, near this centre, heard submarine rumblings, which increased in loudness till the earthquake occurred. Two huge boulders were detached from the neighbouring mountain and rolled into the valley beneath. The same correspondent records that on the afternoon of April 21 there were several violent shocks.

The conditions under which this series of earthquakes has occurred will no doubt be carefully studied. Meanwhile we may call attention to a good article contributed to the *Mediterranean Naturalist* for April by Mr. W. G. Forster, seismologist, manager, and electrician, Eastern Telegraph, Zante, on the earthquakes which did so much damage in January. From this paper we reprint the following historic statement:—

"From the traditions of the place it has always been considered pretty certain that Zante must invariably expect a more or less severe earthquake about every thirty years. I find, however, that this cycle of seismic disturbances is common to all earthquake districts in south-eastern Europe and Asia Minor, and that there exists also a fairly proven and established law which governs these periods of visitation, for instance, whenever any long time has elapsed without the slight shocks—which average one or more a week in earthquake districts of non-volcanic regions—and when to these periods of comparative quiescence succeeds one of constant earth tremors, then a disastrous shock is nearly certain to take place. This is a very important point, and cannot be neglected when the question as to the origin of the shocks is under consideration.

"The last strong local earthquake previous to the present series of shocks occurred on October 26, 1873, and although it was far less severe, it originated within a mile or so of the present one's centrum, as proven by a knot of submarine cable having been then lost, buried under the immense mass which fell into it, at the bottom of the sea; and by the measurements taken at the time.

"This earthquake had precisely the same characteristics as the present one, both previously and subsequently to its occurrence, and although very many severe and slight shocks have been felt since 1873, in no case were they of so pronounced a local nature as those just recently experienced. When the great earthquake of August 27, 1886, occurred, which destroyed Filiatra on the mainland to the south-east of Zante, this island was fortunately outside the direct vibrative waves of seismic forces radiating from the centrum of that shock; which covered up six knots of submarine cable in latitude 37°25′, longitude 21°11′ east of Greenwich; but still it did considerable damage, and its force was severe enough to cause the greatest alarm even in so distant a place as Malta.

"From that year until the spring of 1890 there were numbers of small shocks, but after then and up to August, 1892, only a very few tremors were recorded. On August 16 last year about twelve small shocks suddenly occurred during the day, purely local, and all from east to west. After three days of absolute tranquillity they began again, and although merely pulsations they were of a very pronounced character.

"At midnight on August 27 the shock was strong, and from then until the still smarter shocks of September 3 and 5 the earth seemed always shaking. Another few days of quiescence were followed by a renewal of shocks. This state of things continued until the middle of January last—and was again succeeded by a fortnight of perfect tranquillity. At 9 p.m. on January 30 a very distinct rumbling occurred, which was followed by a short, sharp shock, as if from some falling mass, and then all was still again. I noticed after the shock a series of small ripples on the sea, which was previously and subsequently quite calm. The night passed very quietly until 5.34 a.m., local time, when the whole island began to sway terrifically from east to west, with a purely undulating motion, finishing up by a movement which I can only describe as being similar to that of some mighty force wrenching out the bowels of the earth. This shock lasted twelve seconds, and its centre was undoubtedly in the sea very close to the town, and due east of the same. From its apex of origin its range of destruction, on the frontage of the town, was not wider than two miles, spreading out to about fifteen when it reached the villages at the base of the range of hills, six miles off.

"The destructive force had a tendency to incline from due east to the north-west of the island, which is about 27 miles in length by an average breadth of eight, a subsequent shock taking a much lower range. During the whole day shocks were alarmingly frequent and numbered some hundreds between the first and nightfall when everybody went to the open ground in a most panicstricken condition. At 1.56 a.m. on February 1 another terrific shock took place—not so severe as the first, but with a range towards the south-west and of increasing destructive force. This shock lasted 20 seconds and was also succeeded by numberless others. After 23 hours a third severe shock occurred and periodically during the whole week others of decreasing intensity took place. Since the first shock until the present date, at least one thousand (including pulsations and tremors) have been felt.

"Of course the direct and indirect damage has been very great owing to the extensive zone of destruction, the scattered nature of the villages and to the bad construction of the houses in general and to their dilapidated condition owing to extreme poverty of the island. At least half a million sterling is required to rebuild the place, and as this amount can never be realised many of the ruins are likely to remain untouched and most of the population will have to emigrate."

SCIENTIFIC SERIALS.

American Journal of Mathematics, vol. xv. 1 (Baltimore: Johns Hopkins Press, January, 1893).—The pièce de résistance of this number is a memoir by Prof. Cayley on symmetric functions and seminvariants (pp. 1–74), in which the author further develops the theory of seminvariants, and in connection therewith is led to some investigations on symmetric functions. The subject is treated with characteristic ability and affords ample evidence of the writer's recovery from his recent serious

illness. Prof. Cayley also contributes some tables of pure reciprocants to the weight S (pp. 75–77). Two short notes follow on the differential equation, $\Delta u + k^2 u = 0$ by Maxime Bôcher (pp. 78–83), and geometrical illustrations of some theorems in number by Ellery W. Davis (pp. 84–90, with a diagram). M. Halphen is the mathematician whose portrait is given with this opening number.

Bulletin de l'Académie Royale de Belgique, No. 3 (1893).—Among the scientific papers communicated to the Academy are the following: On the common cause of surface tension and evaporation of liquids, by G. Van der Mensbrugghe. The author deduces from his theory an explanation of the fact that evaporation is more rapid from a convex, and less rapid from a concave, than from a plane surface.—Survival after the successive section of the two vagi, by M. C. Vanlair. Survival after successive section of both the branches of the vagus nerve can be obtained in full-grown animals as well as in young ones. The time necessary for the regeneration of its inferior laryngean branch is generally much longer than that hitherto accepted. In the full-grown dog the period exceeds at least ten months. The regeneration of one branch is quite independent of the section of the other. The question whether the pneumogastric, like the sciatic nerve, possesses the power of regenerating itself twice in succession remains as yet unanswered. It is, however, certain that an interval of six months and a half does not suffice for its second regeneration.—On the digestion of the cœlenterata, by Marcelin Chapeaux. The action of the ferments secreted by the actinia upon starch, cellulose, chlorophyll, and fat, was investigated. Starch submitted to the action of an aqueous solution of these ferments, or injected into the gastrovascular cavity, was transformed into glucose. The action was slow in the case of non-hydrated starch. The transformation took place equally well in acid and in alkaline solutions. Cellulose and chlorophyll were not digested. The fats were emulsioned by the ferments contained in the endodermic cellules. These ferments were without effect upon the algæ. Among the Siphonophora digestion is certainly exclusively intracellular. No dissociation of fibrine is, on the other hand, ever observed in the gastrovascular cavity, and no difference could be established between the alkalinity of the liquid contained in this cavity and the surrounding sea-water.—Contribution to the nitrogen question, by A. Petermann. This is an experimental confirmation of the results of MM. Schlœsing fils and Laurent, showing that free nitrogen is absorbed from the air by the micro-organisms of the soil.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 2.—"Harmonic Analysis of Hourly Observations of Air Temperature and Pressure at British Observatories," by Lieut.-General R. Strachey, R.E., F.R.S.

This paper is a discussion of the results of the computations contained in a volume recently published by the Meteorological Office, of the harmonic components of the first four orders, for each month for twenty years, of the daily curves of temperature and pressure at Greenwich; and for the first three orders, for the temperature and pressure, for each month for twelve years, at the seven observatories maintained by the Meteorological Office.

This system of analysis supplies the means of establishing an exact comparison between various unsymmetrical curves, such as those representing hourly values of temperature, by resolving them into symmetrical components, having periods of twenty-four hours, twelve hours, eight hours, and six hours, and so forth, and its application to the records dealt with in the tables contained in the volume above referred to gives satisfactory proof of the important light it can bring to bear on the periodical changes of diurnal temperature.

In the usual expression the coefficients of the cosines of the arcs are designated by the letter p, and those of the sines by q. The total amplitude of the component is designated by P.

A modification of the usual notation is made by the introduction of the value of the epoch of the first maximum that occurs after midnight, which is designated by the letter μ, and establishes the connexion of the component with the hour of the day and the sun's place more conveniently than the method usually adopted.

1. *Greenwich Temperature.*

The examination of the tables shows that, with very considerable variations of absolute magnitude, there is on the whole very marked consistency in the main characteristics of the components.

Taking as a test the position of the epoch of maximum, which is more directly dependent on the sun's action and on his position than the amplitude, it will be seen that the values of μ indicate very clearly the closeness of this connexion.

In all the components a truly periodical variation of the value of μ is apparent, and the period of maximum always travels backwards, that is, it becomes earlier as the year passes from winter to summer, while it returns in the opposite direction in the change back to winter.

For the first component the variation of the five years' mean of μ from the twenty years is in no month more than $2\frac{1}{2}°$, or ten minutes of time, and the average for all months is less than half that amount.

In the second component the variation of the five-year mean from the twenty-year mean is in no month more than 6°, and the average is only 2°·3, or nine minutes of time.

In the third component the variation of the five-year from the twenty-year mean in no month exceeds 5°, and the average in all months is only 2°·1, or $8\frac{1}{2}$ minutes of time.

The largest variation of the five-year mean of the fourth component for any month from the twenty year mean is 10°, and the average for all months is 4°·3, or seventeen minutes. Considering how small are the absolute values of the coefficients p_4 and q_4, on which the value of μ_4 depends, the average being a little less than $\frac{1}{10}$th of a degree Fahrenheit, it is rather a matter of surprise that the variations should be so small than that they should reach their actual amounts.

The component of the first order, which in the winter is more than double the magnitude of any of the others, and in summer more than ten times as great, gives the dominant character to the daily curves of temperature. In the series of twenty years variations in different years of as much as 100 per cent. are to be found for almost every month, but for the most part even these irregularities disappear in the mean of a series of five years, and the monthly means for the twenty years are remarkably consistent.

The progression of the value of P, in the course of the year, follows approximately the sine of the sun's meridional altitude and the empirical formula

$$P = 10 \cos z - 0{\cdot}91$$

gives a close approximation to the values shown in the tables, if a "lagging" of eight or ten days is allowed in reckoning the sun's place.

The second component has two clearly marked *maxima* about the time of the equinoxes, and a principal *minimum* at midsummer.

The component of the third order varies in a converse manner, having two well-marked *minima* at the equinoxes, with a principal *maximum* at midsummer.

The component of the fourth order appears to combine the characters of the two previous ones, having two *maxima* about the time of the equinoxes, and a principal *minimum* in the winter.

The mean value of μ for the first component is 214°, corresponding to 2h. 26m. p.m., the variation due to season being 12° or 48m. of time, by which the maximum is earlier in summer than in winter.

In the second order the first maximum in June is 24°, or 1h. 20m. earlier than in January.

In the third order the difference in the same direction is 63°, or 4h. 12m. of time.

In the fourth order there is some doubt as to the manner in which the change of epoch of the summer and winter maxima is brought about. But remembering that the fourth component includes four series of undulations, the most probable explanation of these changes is to be found in a change of the position of these undulations, during which, between January and February, when the first maximum is about 10° after midnight, or 0h. 40m. a.m., the first recedes, and its place is taken by the second, which leads to sudden appearance of a maximum about 60°, or 4 a.m. A similar change between October and November in an opposite direction would reproduce the maximum at 10° after midnight.

In the summer months (May, June, and July) the temperature curve during the day hours, from 8 a.m. to 8 p.m., hardly differs from a curve of sines, the first component being more than ten times as large as any of the others, which therefore influence the temperature, relatively, very little.

The relation of the epoch of the first maximum of the component of the third order to the time of sunrise is decidedly marked, the former occurring, on the average, about 12°, or 48m. after sunrise; the mean deviation of the interval from that amount being only 7°, or 28m.

The periodical variation in the position of the maximum leads, during the winter months, to a *positive* maximum of this component about 1 p.m., which is combined with *negative* maxima four hours earlier and later, which correspond to the *reduced* temperature in the mornings and afternoons of the *shorter* days. In like manner, in the summer months, when this component has a negative *maximum* about 1 p.m., instead of a negative *minimum*, as in winter, there will be two *positive* maxima, one four hours earlier, the other four hours later, corresponding to the *higher* temperature in the mornings and afternoons of the *longer* days.

It will be seen that these positions of the midsummer and midwinter maximum phases correspond respectively to days of 16 hours with nights of 8 hours, or days of 8 hours and nights of 16 hours, and that at these seasons, when the variations of temperature, due to these differences, are greatest, the amplitudes of this component are also the greatest. At the equinoxes, with 12-hour days and nights, the component becomes a minimum; and at this season the change in the position of the maximum takes place as already noticed.

It might be supposed that an analogous relation between the fourth component and the occurrence of days of 18 hours, combined with nights of 6 hours, and *vice versâ*, is likely to arise. But the data are not forthcoming to test this.

In the summer months the time of mean temperature is nearly where the first component becomes zero, the second and third components then balancing one another.

In the winter the time of morning mean temperature is later than in summer, and occurs when a positive value of the first component is equal to a negative value of the second.

The time of afternoon mean temperature throughout the year is somewhat either before or after 7 p.m., and almost exactly coincides with the time when the first and second components are equal, with opposite signs.

In the summer the time of absolute minimum is between the hours of 3 a.m. and 6 a.m., during which the whole of the components are negative.

Sunrise in December is about an hour and a half before the time of mean temperature; while in June it is more than four hours earlier.

Sunset in December is rather more than three hours *before* the time of mean temperature; in June it is about half an hour *after* that time.

The *rationale* of some of the empirical rules for obtaining the mean daily temperature from a limited number of observations is supplied by reference to the harmonic expressions for the hourly deviations of temperature from the mean value.

In the first place, it will be seen that by adding together the harmonic expressions for any two hours twelve hours apart, the whole of the *odd* components disappear, and that the sum is twice the mean value, added to twice the sum of the *even* components of the selected hours, which are equal.

By taking the mean of observations at any four hours, at intervals of six hours, both the odd components and those of the second order will disappear, and the result will only differ from the true mean by the amount of the fourth component for the selected hours.

So, if the mean of any three hours at equal intervals of eight hours be taken, the sums of the first, second, and fourth components will disappear, and the result will only differ from the true mean by the amount of the third component for the selected hours, which in no case can be so much as $\frac{3}{4}$°.

2. *Temperature at the Seven Observatories.*

The examination of the tables will show that in their main characteristics the results closely resemble those for Greenwich, and it will not be necessary to discuss them in any detail.

The amplitude of the component of the first order is, however, in all cases less than that observed at Greenwich, the lowest values being those for Valencia and Falmouth, no doubt due to their position on the sea coast, for which stations the means for the years are 2°·28 and 2°·35 compared with 5°·10 at Greenwich.

The Kew values most resemble those at Greenwich, but the mean maximum at Kew is more than 1° less, and the mean for the year $\frac{1}{2}$° less.

The mean values of μ_1 for the seven observatories lie between 205° and 220°, that for Greenwich being 214°. The means of the summer values are about 3° or 4° less than the mean of the year, and of the winter values as much above it, as in the case of Greenwich.

The amplitude of the first component conforms approximately, but not so closely as at Greenwich, with the sine of the sun's meridian altitude, but with a flattening of the curve in the summer months, and a tendency at some of the stations to a maximum value in May.

The components of the second and third orders, beyond which the analyis is not carried for these observatories, conform in all important respects to those for Greenwich, the numerical values of the latter being, however, in all cases somewhat higher. The epochs of maximum follow the same laws, with an increased divergence of the summer epoch from that of the winter at the more northern stations.

In order to test, and in some degree throw light, on the character and significance of the harmonic components of temperature that have been under discussion, and bearing in mind that they cannot be considered to represent separate effects of physical forces operating at the assumed periods of the components, I have, at the suggestion of Prof. G. Darwin, calculated the harmonic components from a curve representing an intermittent heating action such as that of the sun, continued only during a portion of the day, and commencing and ending abruptly at sunrise and sunset.

All cooling effects have been disregarded, and the sun's direct heating action is assumed to be proportional to the sine of his altitude, the power of a vertical sun being taken to be 10. Having calculated the sun's altitude for each hour of the day, for midwinter, the equinox, and midsummer, for certain selected latitudes, the corresponding heating effects have been computed to which the usual method of analysis has been applied.

The comparison of the results thus obtained with the corresponding components derived from actual observation at places having nearly the same latitudes as those selected, establishes their close similarity, and the conclusion is unavoidable, that, although both in the actual and hypothetical cases the harmonic components when combined are truly representative of the peculiar forms of the curves from which they were derived, this affords no evidence of the existence of recurring cycles of action corresponding to the different components, but that the results are, to a great extent, due to the form of the analysis.

The diurnal curve of temperature is *not* symmetrical in relation to the mean value, the maximum day temperature being much more in excess than the minimum night temperature is in defect. To adjust the first component, which *is* symmetrical about its mean value, to the actual unsymmetrical curve, it must be modified by the other components. That of the second order, which has one of its maxima not far removed from the minimum of the first order, supplies the chief portion of the compensation due to this cause.

Further, from the character of the analysis, when the diurnal curve is symmetrical on either side of the hour half way between noon and midnight—that is, when the day and night are equal in length—the third component becomes zero. Any departure from this symmetry introduces a component of the third order, with the result that with a day shorter than 12 hours one maximum will fall in the day between 6 a.m. and 6 p.m., and the other two in the night between 6 p.m. and 6 a.m.; while with a day longer than 12 hours, two maxima will occur in the day and only one in the night. In the former case the negative portions of the component correspond with the reduced morning and afternoon temperatures of the short day, and in the latter the two positive phases correspond with the higher temperature of the mornings and afternoons of the longer day.

These conclusions are in conformity with those previously indicated.

The available data are insufficient to enable us to say whether the corresponding results connected with the fourth component are as fully supported by observation as in the case of the third, but the facts so far as they go confirm this view.

Anthropological Institute, April 11.—Prof. A. Macalister, President, in the chair.—Mr. G. M. Atkinson exhibited a cranium and several metal ornaments found by Mr. A. Michell Whitley and Dr. Talfourd Jones in a grave at Birling, near Eastbourne, Sussex. The peculiar coffin-like shape of the skull seemed to point to its belonging to the early Saxon period, while the metal ornaments were assigned to the late Roman or immediately post-Roman age.—Mr. R. Duckworth read a paper on two skulls from Nagyr, recently added to the Cambridge University collection. One of them is a female skull, and is remarkably dolichocephalic, the cephalic index being 69·94. The other skull is that of an adult male.—Prof. Macalister read a paper on Egyptian mummies. He described the manner in which they were prepared, the unguents used by the Egyptians and the various cloths in which the mummies were rolled. He explained the difference between the Egyptian cloths and those manufactured in England at the present day, and said that the object of using so few threads in the weaving was for the purpose of saving time and trouble. The material at the same time was brought to a high state of perfection as a manufacture, and indeed might even compare with some of the finest linen productions at the present day. Specimens of cloth were exhibited and the author stated, on the authority of a linen manufacturer, that there was only one specimen of linen manufacture in the United Kingdom which could be recognised as of similar structure to the Egyptian productions.—A paper on Damma Island and its natives by P. W. Bassett Smith, R.N., was also read.

Geological Society, April 12.—W. H. Hudleston, F.R.S., President, in the chair.—The following communications were read:—On some Palæozoic Ostracoda from Westmoreland, by Prof. T. Rupert Jones, F.R.S. In 1865 the author determined for Prof. Harkness some fossil Ostracoda which he had obtained from the Lower Silurian rocks of South East Cumberland and North-East Westmoreland, and subsequently other specimens mentioned by Harkness and Nicholson in 1872. In 1891 Prof. Nicholson and Mr. Marr submitted a series of similar microzoa from the same district; and the author now endeavours to determine their specific alliances, and revises the list of those previously collected. He has to notice about eleven forms of *Primitia*, *Beyrichia*, *Ulrichia*, *Æchmina*, and *Cytherella*—several of them being closely allied as varieties, but all worthy of study as biological groups, such as have been illustrated from other regions by writers on the Ostracoda, with the view of the exact determination, if possible, of species and genera, of their local and more distant or regional distribution, and of their range in time. —On some Palæozoic Ostracoda from the Girvan district in Ayrshire, by Prof. T. Rupert Jones, F.R.S. This paper aims at the completion of the palæontological account of the Girvan district, so far as the Ostracoda are concerned; and follows up the researches indicated in the "Monograph of the Silurian Fossils of the Girvan District in Ayrshire," by Nicholson and Etheridge, vol. i., 1880. In about a dozen pieces of the fossiliferous shales, submitted for examination some few years ago, the writer finds nearly thirty specimens of *Primitia*, *Beyrichia*, *Ulrichia*, *Sulcuna*, and *Cypridina* which show interesting gradations of form, not always easy to be defined as specific or even varietal, but valuable as illustrating modifications during the life-history of individuals, thus often leading to permanent characteristics of species and genera. Like those formerly described in Nicholson and Etheridge's "Monograph," the specimens have all been collected by Mrs. Elizabeth Gray, of Edinburgh.—The reading of these papers was followed by a discussion, in which the President, Mr. Marr, and the author took part.—On the dwindling and disappearance of limestones, by Frank Rutley. The existence of chert between two sheets of eruptive rocks at Mullion Island seemed to the author to require some explanation. Cherts are usually associated with limestones, and the absence of limestones in many cases where cherts are found points to their removal by underground waters. The older the limestone the greater the probability of its thickness having dwindled. The thicknesses of the Ordovician, Silurian, Devonian, and Carboniferous Limestones seem to be in the ratio of 1 : 15 : 15 : 100. Many limestones once existing in Archæan rocks may have disappeared, as also limestones in later rocks. The author comments on the difficulty of distinguishing some cherty rocks from felstones. Two appendices are added to the paper, the first on the transference of lime from older to newer deposits, and the second on the formation of nodular limestone-bands.—This paper gave rise to a discussion in which the President, Prof. Hull, Mr. Walford, Prof. Judd, General McMahon, Prof. T. R. Jones, Prof. Hughes, Mr. H. W. Monckton, Dr. G. H. Hinde, and the author took part.—On some Bryozoa from the Inferior Oolite of Shipton Gorge, Dorset, Part II., by Edwin A. Walford.

Royal Meteorological Society, April 19.—Dr. C. Theodore Williams, President, in the chair.—The following papers were read:—The direction of the wind over the British Isles, 1876–80, by Mr. F. C. Bayard. This is a reduction on an uniform plan of the observations made twice a day, mostly at 9 a.m. and 9 p.m., at seventy stations during the lustrum 1876–80; and the results are given in tables of monthly and yearly percentages.—Notes on two photographs of lightning taken at Sydney Observatory, December 7, 1892, by Mr. H. C. Russell, F.R.S. These photographs were taken with a half-plate view lens, mounted in a whole plate camera, and, as a matter of course, there is some distortion at the edges. Both photographs show the gaslights in the streets as white specks, the specks being circular in the centre and crescent-shaped in other parts of the plate owing to distortion. The lightning flashes are also distorted. Mr. Russell believes that this distortion may account for the so-called "ribbon" flashes, which are seen in many photographs of lightning. He has also made some measurements of the length and distance of the flashes, and of the intensity of the light.—Notes on lightning discharges in the neighbourhood of Bristol, 1892, by Dr. E. H. Cook. The author gives some particulars concerning two trees in Tyntesfield Park, which were struck by lightning, one on June 1 and the other on July 18, and also some notes concerning a flagstaff on the summit of Brandon Hill, which was struck on October 6.—Constructive errors in some hygrometers, by Mr. W. W. Midgley. The author, in making an investigation into the hygrometrical condition of a number of cotton mills in the Bolton district, found that the mounting of the thermometers and the position of the water receptacle did not by any means conform to the regulations of the Royal Meteorological Society, and were so arranged that they gave the humidity results much too high. The Cotton Factories Act of 1889 prescribes the maximum weight of vapour per cubic foot of air at certain temperatures; and the author points out that if the instruments for determining the amount present in the mills have an error of 20 per cent. against the interests of the manufacturer, it is necessary that the makers of the mill hygrometers should adopt the Royal Meteorological Society's pattern for the purpose.

PARIS.

Academy of Sciences, April 17.—M. Lœwy in the chair. —Note on the observation of the partial eclipse of the sun of April 16, 1893, by M. F. Tisserand.—On the observation of the total eclipse of the 16th inst., by M. J. Janssen.—Effects of the drought upon this year's crops; reply to M. Demontzey's note on the planting of the highlands, by M. Chambrelent.—Expansion of water at constant pressure and at constant volume, by M. E. H. Amagat. At pressures higher than 200 atmospheres water has no maximum density above zero. At the lower temperatures, contrary to what takes place in the case of other liquids, the coefficient of expansion increases with the pressure. This increase is gradually effaced as the temperature rises, is sensibly zero at 50° or 60°, and changes sign for higher temperatures. If water is kept at a constant volume the pressure increases rapidly with the temperature. Thus, for unit volume the coefficient of pressure increases fourfold between 10° and 100°, and the variation is proportionately even more rapid between 0° and 10°.—On the structure of simple finite and continued groups, by M. Cartan. —On a simple group with fourteen parameters, by M. F. Engel.—Demonstration of the transcendental nature of the number e, by M. Adolf Hurwitz.—Comparison of the international meter with the wave-length of cadmium light, by M. Albert A. Michelson.—Photography of gratings engraved upon metal, by M. Izarn. It is possible to reproduce opaque gratings engraved upon metal in a manner analogous to the reproduction of transparent ones already described. On covering such a grating with a layer of bichromated gelatine, and exposing to the sun through this layer, a grating effect is produced which, although rather feeble, is due to successive differences of structure corresponding to the rulings. These differences of structure are probably due to stationary reflected waves, and

need not necessarily be alternations of transparency and opacity in order to produce the desired effect. Very close contact between the film and the grating is essential.—On atmospheric polarisation, by M. A. Hurion.—Researches on the higher alcohols and other impurities in vinic alcohol, by M. Émile Gossart.—On the general relations which exist between the coefficients in the fundamental laws of electricity and magnetism, by M. E. Mercadier.—On the reflection of electric waves at the end of a linear conductor, by M. Birkeland.—Multiplication of the number of periods of sinusoidal currents, by M. Désiré Korda.—On the hygroscopic properties of several textile fabrics, by M. Th. Schlœsing fils.—Contribution to the study of the Leclanché cell, by M. A. Ditte.—Attempt at a general method of chemical synthesis; formation of nitrogen compounds, by M. Raoul Pictet.—On the stereochemistry of the malic compounds, and the variation of the rotatory power of liquids, by M. Albert Colson.—On a chlorobromide of iron, by M. Lenormand.—On the saccharates of lime, by M. Petit.—On a new soluble ferment doubling trehalose into glucose, by M. Ém. Bourquelot.—On the circulatory apparatus of *Mygale Cæmentaria*, Walck, by M. Marcel Causard.—Influence of the pressure of gases upon the development of vegetables, by M. Paul Jaccard.—On the ammonite layers of the inferior Malm in the county of Montejunta, Portugal; little known phases in the development of the mollusca, by M. Paul Choffat.—On the mode of reproduction of the parasites of cancer, by MM. Armand Ruffer and H. G. Plimmer.—M. Lippmann presented to the Academy, in the names of MM. Auguste and Louis Lumière, coloured photographs obtained by the interference method.

BERLIN.

Physical Society, March 10.—Prof. Kundt, President, in the chair.—The President gave an account of some researches undertaken as an introduction to the study of Hall's phenomenon. As is well known, this is directly proportional to the intensity of the primary current, but inversely proportional to the pressure of the plates; on the other hand, it is not strictly proportional to the magnetising current in the case of the several metals so far examined, and it appeared probable that it might more possibly be proportional rather to the magnetisation of the plate. Prof. Kundt wished to test this possibility in the case of iron, nickel, and cobalt, employing transparent metallic films of these metals magnetised to 28,000 units, whose magnetisation could be tested directly by means of their rotatory power. It was found that the Hall effect increased hand in hand with the increase of rotatory power, and therefore proportionally to the magnetisation of the plates. The effect was, as Hall had already shown, positive in the case of iron and cobalt, negative in that of nickel. Bismuth deposited electrolytically in a transparent film gave very feeble or no results, whereas, when drawn out into a thin plate the effect was considerable.—Dr. Wren spoke on Maxwell's proposition that waves of light exert pressure in the direction of their transmission, as proved in a certain case by Boltzmann. He deduced, under certain assumptions, a formula for the calculation of temperature based upon a determination of maximal energy.

AMSTERDAM.

Royal Academy of Sciences, March 25.—Prof. van de Sande Bakhuysen in the chair.—Mr. Pekelharing spoke of the peptone of Kühne. Some years ago he argued there was not a real difference between the substances called peptone, and the substance called propeptone or hemialbumose. The researches of Kühne and his disciples afterwards proved that what was called peptone by Schmidt-Mülheim and by Salkowski, contained albumose. But it was not proved by Kühne that the substance called by himself peptone was really free from albumose. Out of a solution of Kühne's peptone, saturated with ammoniumsulphate, there can be precipitated by metaphosphoric acid, and more fully by trichloracetic acid, a substance which has the properties of albumose. It gives the biuretreaction, it is precipitated, the reaction may be acid, neutral, or alkaline, by ammoniumsulphate, it is precipitated by picrinic acid, and, in acid solution, by saturation with natriumchlorid. So it is clear that there is no ground for believing with Kühne that the substance called by him peptone is a substance *sui generis*, and not an impure albumose.—Mr. Bakhuis Roozeboom dealt with the cryohydrates in systems of two salts. Three cases are to be considered. The first is that the two salts may exist without combination. Then there is a cryohydratic point in which the two salts A and B exist with ice next the solution. This point is a minimum temperature. Besides, there are two cryohydratic lines, representing the series of solutions which may exist with ice and A or ice and B as solids. In the other cases when A and B form a double salt D, there are two cryohydratic points, one for the solution in equilibrium with ice + D + A, the other for ice + D + B; and three cryohydratic lines for the solutions in equilibrium with ice + D, ice + A, ice + B. When the double salt is soluble without decomposition, the two cryohydratic points are both minimum temperatures, and therefore there must exist a maximum temperature on the line for ice + D; this maximum relates to the solution which presents the same relation A/B as in the double salt. All these conclusions may be deduced from thermodynamical rules; they were confirmed in experimental research by Mr. Schreinemakers.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Carlsbad, a Medico-Practical Guide: Dr. E. Kleen (Putnam).—Louis Agassiz, his Life and Work: Dr. Holder (Putnam).—Die Natürliche Auslese beim Menschen: O. Ammon (Jena, Fischer).—Public Health Laboratory Work: H. R. Kenwood (Lewis).—Annual Statement of Works carried out by Public Works Department (Sydney, Potter).—The Principles of Agriculture: G. Fletcher (Derby, Central Educational Company).—Science et Religion: T. H. Huxley (Paris, Baillière).—Au Bord de la Mer: Dr. E. L. Trouessart (Paris, Baillière).—Conférences Scientifiques et Allocutions—Constitution de la Matière: Lord Kelvin. Traduites et Annotées sur la Deuxième Edition: P. Lugol and M. Brillouin (Paris, Gauthier-Villars).—Premiers Principes d'Électricité Industrielle: P. Janet (Paris, Gauthier-Villars).—The Great Barrier Reef of Australia: W. Saville-Kent (W. H. Allen).

PAMPHLETS.—Meteorological Results deduced from Observations taken at the Liverpool Observatory during the Years 1889, 1890, 1891 (Liverpool).—On the Effects of Urban Fog upon Cultivated Plants: Prof. F. W. Oliver (Spottiswoode).—The Fundamental Hypotheses of Abstract Dynamics: Prof. J. G. MacGregor.—Il Clima di Torino: G. B. Rizzo (Torino, Clausen).—On the Application of Interference Methods to Spectroscopic Measurements: A. A. Michelson (Washington, Smithsonian Institution).—Recreation: W. Odell (Torquay, Iredale).

SERIALS.—Journal of the Chemical Society, April (Gurney and Jackson).—Annalen des k. k. Naturhistorischen Hofmuseums, Band viii. No. 1 (Wien, Holder).—Timehri, No. xxii. (Stanford).—Notes from the Leyden Museum, vol. xv. No. 2 (Leyden, Brill).—L'Anthropologie, tome iv. No. 1 (Paris, Masson).—Journal of the Royal Microscopical Society, April (Williams and Norgate).—The Asclepiad, No. 37, vol. x. (Longmans).—Records of the Geological Survey of India, vol. xxvi. Part 1 (Calcutta).

CONTENTS.